Irrigation in India.—The Ashti Tank*.

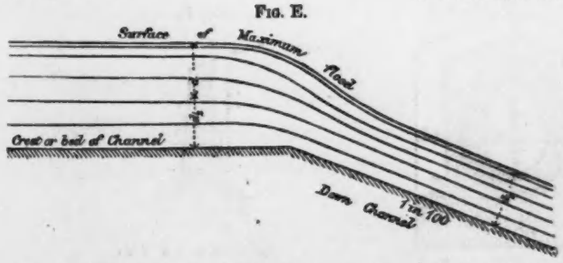
BY CHARLES TOLER BURKE, B. E., M. Inst. C. E.

(Concluded from Page 28.)

In discussing the question of the top breadth, it was pointed out that renewals and repairs were necessary to bring the top of the dam to its proper level, owing to the inevitable settlement of the earth-work, and it will be readily understood that such settlement cannot take place without affecting the slopes of the upper section of the dam. This has occurred in the Ekruk tank dam and in consequence the repaired slopes are much steeper than those which originally prevailed. Of course this might be obviated by extending the new slopes further down the outer side of the dam; but then the saving, which is the only reason for making the upper slope 1½ to 1, must in time be lost. It is therefore recommended that the outer slope of all earthen dams be made of a uniform slope throughout, and this should be fixed at 2 to 1, as it does not appear that the frictional stability of the soils used in the Deccan is sufficiently great to warrant the general adoption of a greater inclination.

As regards the inner slope, the inclination should be designed at 3 to 1 up to the level of the estimated maximum flood in the tank, then changing to 1½ to 1 to the top of the dam; the alternation of slopes ought not to be abrupt, a flat curve should connect the two. The inner slope is given an inclination of 3 to 1, because being immediately in contact with the water, the frictional stability of the earth is diminished; and, for the same reason, it is obvious that any part of the slope upon which floods are likely to rise should have a similarly flat inclination. The saturation of earth is a rapid process, the pitching, not being watertight, affords little protection against a slip in the underlying material, and if such once set in, its weight would rather tend to facilitate this. It is a matter for consideration whether the upper part of the inner slope should not be 1 to 1 rather than 1½ to 1; it would probably be an advantage that waves should be reflected rather than broken on the slope, and on the authority of Mr. Scott Russell, it appears that a slope of 1 to 1 will reflect waves, while on flatter slopes they are broken. The cross-section which the author recommends for general adoption in India is shown in Plate 1, Fig. 4, where

FIG. E.



t = the top breadth, which, for dams of 50 feet and over in height = 10 feet; and for less than 50 feet in height = 8 feet.

h = height of dam above "full supply" level, or the crest of weir = $d + x + c$.

d = depth of water in tank, above weir-crest level, when the estimated maximum flood is flowing over the weir.

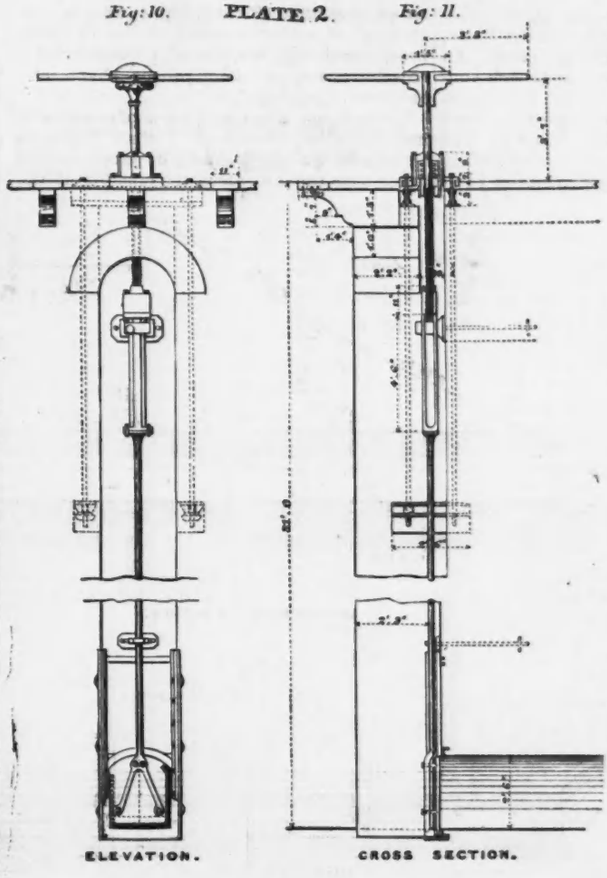
x = height of top of pitching above surface of the estimated flood in the tank, found from the formulæ $x = 1.5\sqrt{F} + (2.5) - \sqrt[3]{F}$ already quoted; and

c = a constant of the value of 2 or 3 feet according to circumstances, that is, the vertical height of the top of the dam above the top of the pitching.

The site of the waste-weir channel, designed to provide for the escape of flood water, is shown in Plate 2, Fig. 1, and its general outline, form of approach, etc., in Plate 2, Figs. 8 and 9. The waste-weir consists of a channel,

*From other selected Papers of the Institution of Civil Engineers.

Fig: 10. PLATE 2. Fig: 11.



having a clear width of 800 feet, excavated through a saddle in the high ridge constituting the western boundary of the tank. The bed of this channel, forming its crest or sill, is level for a mean length of about 600 feet, and then falls away with a slope of 1 in 100 towards the Rapla nala, into which the flood waters are discharged, and are thus passed into another valley distinct from that draining into the tank. This is a very desirable and advantageous arrangement.

The height of the dam above the crest of the weir is 12 feet; it has been calculated that a flood-discharge, equal to 48,000 cubic feet per second, would rise to a height of 7 feet above the crest; or to within 5 feet of the top of the dam. This margin is considered sufficient, as such a flood will be of exceptionally rare occurrence, and cannot last long at such a height. A discharge of 48,000 cubic feet per second is equivalent to a "run off" of 0.80 inch per hour from the whole drainage area, and experience proves it to be very improbable that such a large flood will ever occur; but on the other hand, the construction of the waste-weir was comparatively an inexpensive work, and there would have been no advantage, and but little economy, in making it of smaller discharging capacity.

The catchment-basin is generally flat, and consists largely of cultivated and arable land; there are no hills in the vicinity, nor are there any peculiarities of shape or slope to indicate that the catchment is liable to sudden, or very heavy floods. The material through which the channel has been excavated is muram of various degrees of hardness, and the bed of the channel is soft rock.

The following calculations have been made on the discharging capacity of the waste-weir channel (Fig. E):

Let the width of channel = L = 800 feet.

Let the depth of water in channel = d_2 = 3.5 ft.

Slope of surface of the channel = 1 in 100.

Mean velocity in the channel, as given by the formulæ,

$$v = 92.26\sqrt{\frac{h}{e} \times d_2}$$

$$= 92.26\sqrt{\frac{1}{100} \times 3.5}$$

= 17.25 feet per second, and the corresponding discharge = 48,300 cubic feet per second. (1)

The head of water in the tank, necessary to cause a discharge of 48,000 cubic feet per second, may be determined from the formulæ—

$$D = C_d L d_2 \sqrt{2g d_1} + \frac{2}{3} C_d L d_1 \sqrt{2g d_1}$$

d_2 may be taken as the depth in the channel, or = 3.50 feet. From experiments made in a similar channel, it was found that for a depth of 3 ft. in the channel the coefficient was = 0.75,

$$\therefore D = 0.75 \times 800 \times 3.50 \times 8.02\sqrt{d_1} + \frac{2}{3} \times 0.75 \times 800 \times 8.02\, d_1\sqrt{d_1},$$

$$D = 0.75 \times 800 \times 8.02\sqrt{d_1}\left(d_2 + \frac{2}{3}d_1\right),$$

$$48{,}000 = 4812 \times \sqrt{d_1}\left(3.50 + \frac{2}{3}d_1\right),$$

or d_1 = 3.20 feet, nearly (2)

and the total depth or head of water on the crest of the weir

= $d_1 + d_2$ = 3.20 + 3 = 6.70 feet:

or, in round numbers, the head of water in tank, above the level of the weir-crest, will be 7 feet when the assumed maximum flood of 48,000 cubic feet per second is passing through the waste-weir channel.

There are two outlets, or regulators, one on the left and the other on the right bank of the river, through which the water of the tank is passed and regulated in its passage into the canals. The general designs and details of of these works are shown in Plate 2, Figs. 10 and 11, and Plate 3, Figs. 1 and 2. The regulator on the left hand is the headwork of the larger and more important of the two canals. It consists of a sluice-wall, which takes the place of the ordinary tower; in this wall two arched outlets are constructed, in which two sluice-valves are fixed for the purpose of admitting and regulating the supply of water to the canal. A relieving arch in the wall bears the weight of the superincumbent masonry, and is connected

by a conical or funnel-shaped archway with a culvert constructed in the natural ground under the dam, through which the water flows into a receiving-basin at the toe of the outer slope of the dam. In this basin the velocity due to the head of water in the tank is, in consequence of the large capacity of the basin, decreased before passing into the canal. An iron foot-bridge and embanked approach connects the sluice-wall with the dam. The foundations of the wall, culvert, etc., are of concrete (Plate 3, Fig. 1), laid upon hard muram. The concrete consists of equal parts of lime freshly burnt and ground, and clean sharp river sand made into mortar, and then mixed with 1 part of gravel and 3 parts stone broken to 1½ inch gauge. The concrete was laid in the foundations in layers 7 inches thick, and rammed throughout quickly, so as to ensure the whole being completely consolidated before the lime had set; under this operation, it was found that the layers were reduced to 6 inches in thickness.

The sluice-wall (Plate 3, Fig. 1), is flanked by two wing-walls, which support the inner slope of the dam at this part, and form an entrance-channel leading to the sluice-valves. The sluice-wall is faced with block-in-course masonry laid in 8 inch courses, in which the dimensions of the stretchers are 1 foot 4 inches by 1 foot by 8 inches, and of the headers 2 feet by 1 foot by 8 inches. The hearting is of uncoursed rubble masonry, the whole being laid in ordinary lime-mortar. The wing-walls, and walls of the relieving-basin are of block-in-course work. The culvert has an ovoid section (Plate 3, Fig. 4), and is constructed of ashlar masonry 1½ foot in thickness, consisting wholly of through stones chisel-dressed to their proper shape and enclosed in concrete.

Three flanges are constructed of concrete at intervals along the culvert (Plate 3, Fig. 1), so as to prevent any leakage, or creep of the water from the tank along the junction of the earthwork with the concrete. These and the arrangements generally for the prevention of leakage at the junction of the outlet works with the dam have been successful; and since the first filling of the tank in 1880 there has not been any leakage or creep of any kind, and the works are in every way watertight and staunch. The form of cross-section of the culvert (Plate 3, Fig. 4), is well suited for an outlet of this kind.

Rankine states[1] that the proper form for the line of pressure is the "elliptic linear arch," in which the ratio of the half-span to the rise shall not be less than the square root of the ratio of the horizontal to the vertical pressure of the earth; that is to say:

$$\frac{\text{Half span}}{\text{Rise}} \text{ shall not be less than } \sqrt{\left(\frac{1-\sin\Phi}{1+\sin\Phi}\right)};$$

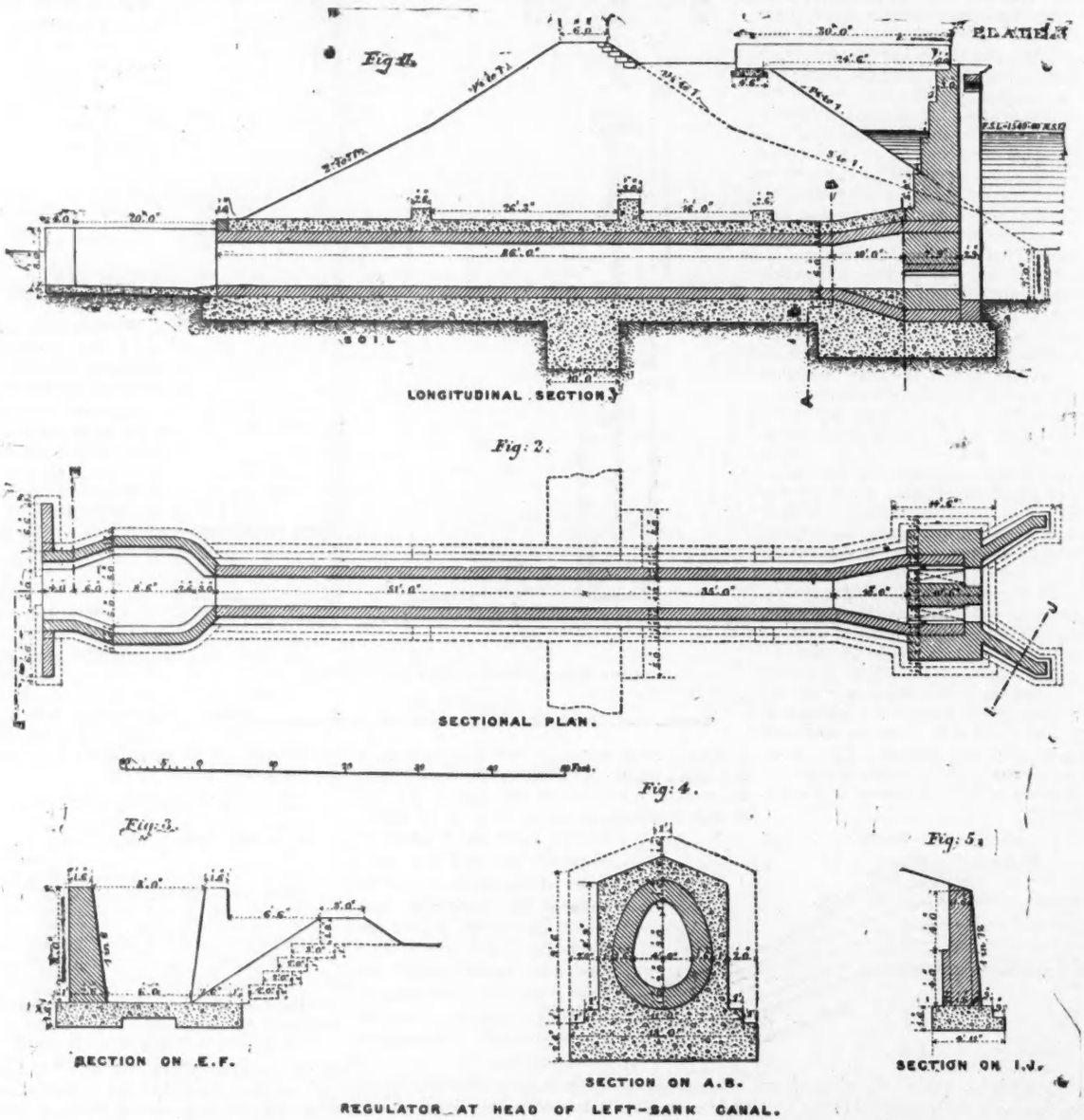
where Φ = angle of repose, which in this case would not be less than 45°.

Then $\sqrt{\left(\frac{1-\sin\Phi}{1+\sin\Phi}\right)} = \sqrt{0.172} = 0.414.$

The proportion given in the design for the culvert is 0.5, therefore there is an excess of strength. It may be here remarked that, owing to the position of the culvert buried as it is in the underlying hard muram, there would be but little horizontal pressure arising from the pressure of the dam; the excess of the strength in this direction is therefore all the greater.

Again, Rankine states, "In a drainage tunnel or culvert the entire ellipse may be used as the figure of the arch;" but where it is necessary, or convenient, as it is in this case, the bottom may consist of a "circular segmental inverted arch." He gives its depression as one-eighth of the span. This is obviously a minimum, as a semi-circle in which the depression is half the span must possess the

[1] "A Manual of Civil Engineering," 2d edition, p. 434.



REGULATOR AT HEAD OF LEFT-BANK CANAL.

maximum of strength. He further points out that "the greatest intensity of pressure in a buried archway occurs usually in its sides, at the ends of the shorter diameter," and this pressure is given by the following formula—

$$q = \frac{w\left\{ (b+t) - 0.8\,a\,b \right\}}{t};$$

which should not exceed the resistance to crushing of the material, divided by a proper factor of safety.

In the above formula.

= the greatest pressure in lbs. on the sq. ft.
w = weight of a cbc. ft. of earth = 110 lbs.
b = half-span ..... = 2 ft.
a = rise ..... = 4 ft.
t = thickness of the side ..... = 1 ½ ft
x = depth of shorter diam. below the top of dam. = 32 ft.

$$q = \frac{110\left\{ 32\left(2 + 1\tfrac{1}{2}\right) - 0.8 \times 4 \times 2 \right.}{1\tfrac{1}{2}}$$

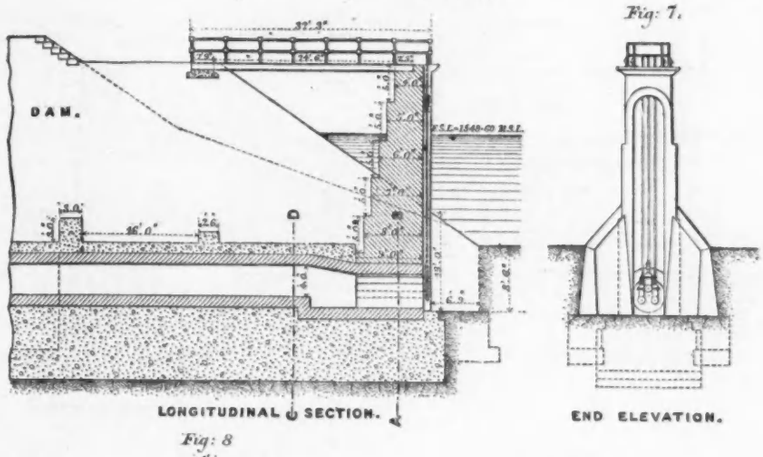
= 7.744 lbs. per square foot,
or = 54 lbs. nearly per square inch.

And as the working load, or safe limit of pressure, would not be less than 250 lbs. per square inch, there is an excess of strength in the section. There would in this and such cases be objections to constructing the lower part of the culvert of an elliptic section, as the discharging power of the culvert would be reduced when the water fell to a low level in the tank; this might be remedied by giving a greater longitudinal fall to the culvert, or by lowering the floor level, but it would involve either a loss of head in the canal or of water in the tank.

In cases of outlets or regulators for irrigation works of this kind this form of section of the culvert is probable the strongest, and, all circumstances considered, the most desirable for general adoption.

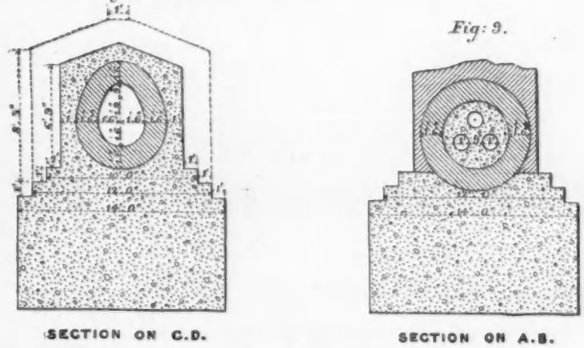
The sluice-valves (Plate 2, Figs. 10 and 11), consist of two sliding gates, each gate having clear openings of 2 feet square. The discharging power of each valve has been calculated at 20 cubic feet per second, assuming a head of water in the tank of 1 foot, as follows:

Fig: 6. PLATE 3. Fig: 7.



LONGITUDINAL SECTION. END ELEVATION.

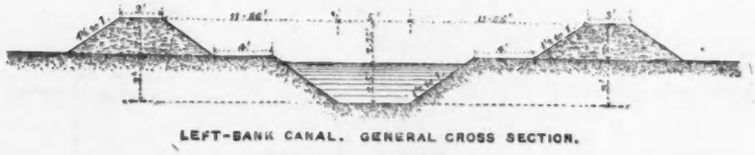
Fig: 8 Fig: 9.



SECTION ON C.D. SECTION ON A.B.

REGULATOR AT HEAD OF RIGHT-BANK CANAL.

Fig: 10.



LEFT-BANK CANAL. GENERAL CROSS SECTION.

Bottom width ..... = 5 feet.
Depth of Water ..... = 7½ feet.
Side Slopes ..... = 1½ to 1.
Fall ..... = 1 ft per mile.
Mean velocity ..... = 1·3503 per second.
Discharge ..... = 20·00 cubic feet.

$$\text{Discharge} = \text{area} \times C_d \times 8.025 \sqrt{H.}$$
$$= 4 \times 0.625 \times 8.025 \sqrt{1.}$$
$$= 20.06 \text{ cubic feet per second.}$$

The details of the lifting gear, or arrangement for lifting the sluice-gates, are fully illustrated in Plate 2, Figs. 10 and 11. The gear consists of a capstan which turns a screw, thus raising a nut which forms part of the lifting-rod attached to the sluice-gate, and by which motion the gate is raised or lowered. The total cost of this regulator, including all masonry, concrete and arch-work, foot-bridge, valves, etc., amounted to Rs. 8,479.

The outlet (Plate 3, Figs. 6 to 9) or regulator forming the head-work of the right bank canal is similar in form, design and construction, that just described, with the exception of the valves, which are three double-faced sluice-valves of the ordinary pattern in use in works of water-supply, each 12 inches in diameter, fitted to one length of cast-iron pipe and laid in position as shown in Plate 3, Figs. 6 and 7. The total cost of this regulator, including all masonry, concrete arch-work, foot-bridge, valves, etc., amounted to Rs. 8,076.

The two canals as constructed, one on the left and the other on the right bank of the river, are taken from the tank (Plate 2, Fig. 1); both commence at 22 feet below the level of "full supply" in the tank. As originally designed, these canals were arranged to "take off" at a level 5 feet lower than that at which they now commence; the length of that on the left bank being 18¼ miles, and that on the right 11 miles, commanding respectively 9,307 and 4,017 acres, or a total of 13,324 acres of land. The left bank canal was designed to discharge 30 and the right bank 10 cubic feet per second, and the dimensions of the cross-sections and bed-falls had been calculated by Neville's Hydraulic Tables.

In sanctioning the project the Government of India remarked that, in calculating the velocities in the canals, too high a coefficient had been used, and suggested that either the bottom widths should be enlarged, or the depths of water in the canals increased, in order to obtain the desired discharge. It was subsequently intimated that Bazin's coefficient should be used in the calculations, unless the divergence from the inclinations of bed and types of channel in the Darcy-Bazin experiments were so great as to indicate the propriety of adoping the modifications suggested by Kütter. Under instructions from the Chief Engineer for Irrigation, the author had fresh surveys made, the alignment of the canals altered, and all the works designe l anew, the results being that the length of the left bank canal was reduced to 11 ¾ and that of the right to 10 miles; thus by improved alignment the combined length has been reduced by 8 miles, while at the same time the area under command has been increased to 10,990 acres under the left bank, and 5,174 acres under the right bank canal, or to a total area of 16,164 acres. Further, the canals are capable of extension to command a total area of 25,270 acres.

In re-designing these canals, the great ob ject aimed at was to increase the area of land under command. There exist no data for which a fixed relative proportion can be determined between the area which an irrigation work is capable of supplying annually, and the minimum area which it is desirable that such a work should command; but there can be no doubt of the importance of obtaining as large an area under command as possible. Experience gained on existing works goes far to prove how essential it is to the early financial success of a work, that the area commanded should bear a large proportion to that for which the water-supply is sufficient. There are many causes which retard the irrigation even of irrigable land, such as:

1. Inferiority of soil.
2. Configuration of the land.
3. Distance of the holdings from the villages.
4. Comparatively large areas of holding in the hands of proprietors too poor to cultivate the whole.

In this case it was found that, in order to secure the more important object of increasing the area of land under command, it was impossible to obtain as great velocities as are considered desirable, and which in larger canals would be necessary to prevent an undue growth of weeds. Silt cannot be brought into the canals, as they are doubled banked throughout, and all cross-drainage is passed either under or over, not through or into the canals. Moreover in small canals of this class, which can be laid dry periodically, the expense involved in clearing weeds is trifling; and it will generally be found much more advantageous to accept this disadvantage than

to sacrifice the area under command, which would in most cases be lost by designing such canals with heavy bed-falls to produce velocities sufficient to prevent the growth of weeds. The cross-section of the canal (Plate 3, Fig. 10) is the type of that generally adopted where the canal is in cutting. Where the canal is in embankment there are no berms.

The masonry works on these canals are of ordinary character. The largest aqueduct (Plate 3, Figs. 11 to 15) is that on the left bank canal over the Koneri nala. This consists of six segmental arches of 20 feet span each having a rise of 3½ feet. There are altogether four aqueducts having arches of this span, and the centers constructed for the first were used for the others.

The super-passages are of the general design shown in Plate 3, Figs. 16 to 18. This description of drainage work, by means of which the cross-drainage is passed over the canal, is admirably adapted to canals of this class, and is most economical. The cost of construction is small, it acts efficiently as a drainage work, and in fair weather is available as a road-crossing, thus nearly altogether doing away with the necessity for occupation-bridges.

The form of irrigation outlets in use on these canals is shown in Plate 3, Figs. 19 and 20. These outlets are constructed in the side of the canal where in cutting, and form the head-work of each distributing channel. The outlet consists of two short cast-iron pipes 6 inches in diameter, one forming the inlet or "take off" from the canal, and the other being placed at the outfall to form the outlet end: the intermediate lengths are earthenware pipes of native make each 1 foot in length. The pipes terminate and discharge into a cistern (Plate 3, Fig. 20).

This cistern is square in plan, and is constructed of rubble masonry, having openings in the sides for the passage of water into the distributing channels. The inlet end of the pipe is fitted with a conical wooden plug for shutting off the supply; while at the outlet end by a second plug, the position of which can be altered by an iron pin passing through it, the supply to the distributing channel can be regulated. This form of outlet costs about Rs. 30, and is well suited for works of this class. The estimated average number of these outlets required is five per mile of main canal. Where the area of land is larger than can be irrigated by one of these outlets, the number of pipes can be increased, but the diameter of each is maintained at 6 inches as most suitable for all purposes.

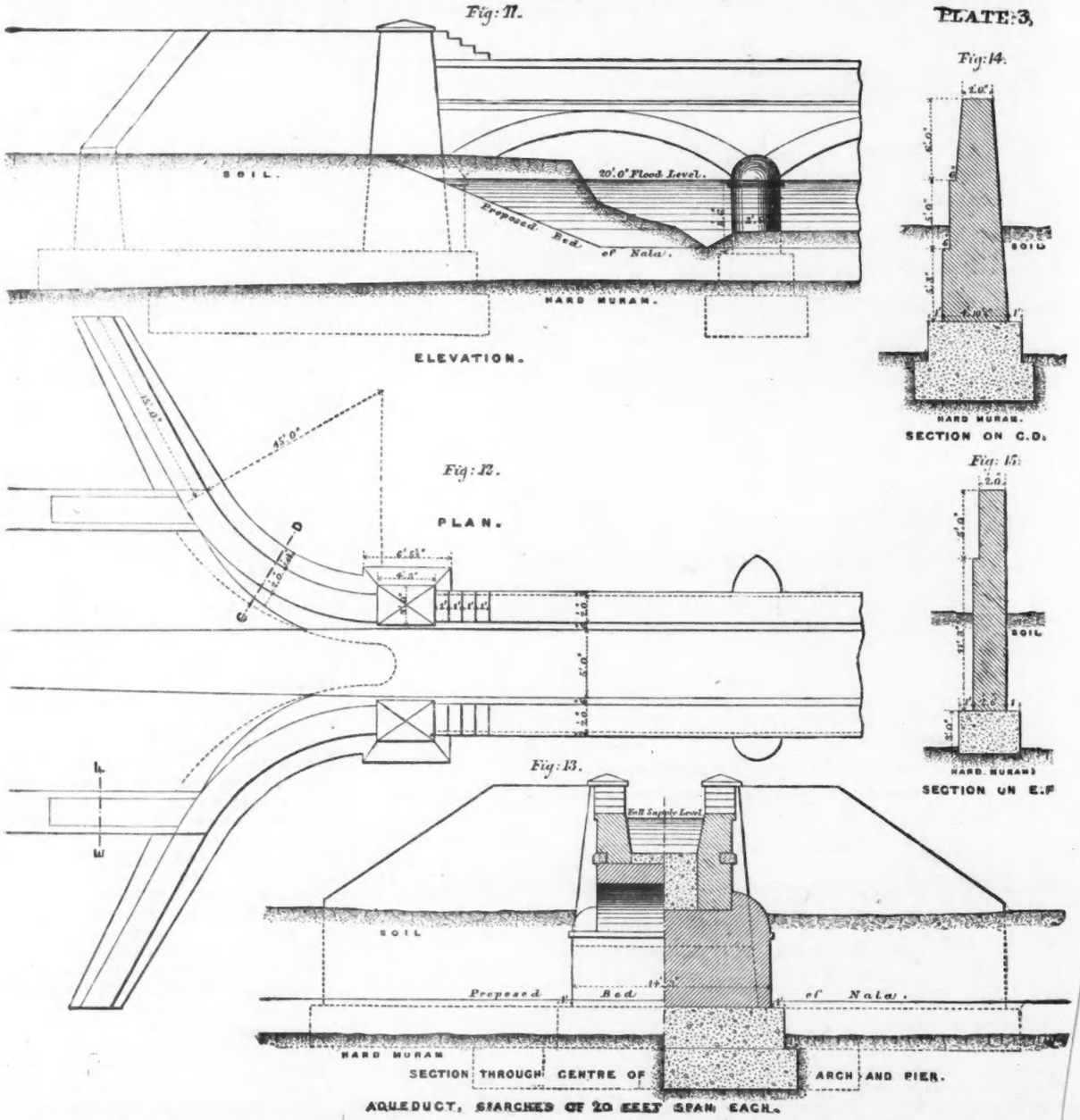
The estimated cost of the main canals per mile, distributed under the following sub-heads, is as follows:

	Left Bank Canal.	Right Bank Canal.
	Rupees.	Rupees.
Land compensation	140	140
Masonry works, including all drainage and road works, but exclusive of the main outlet from the tank.	3,082	2,761
Earthworks	2,069	1,309
Irrigation outlets	150	150

The following abstract shows the cost per 1,000,000 cubic feet of water stored, in the case of reservoirs completed in the Bombay Presidency, having earthern dams and works similar to those of the Ashti tank. The rate includes the cost of the dam, waste-weir, regulators, and compensation paid for land occupied by the tank.

District.	Name of Work.	Cost per Million Cbc. Ft. of Water Stored.	Remarks.
		Rupees	
Sholapur..	Ashti tank	277	Completed.
"	Ekruk "	227	"
"	Pangoan tank	255	Estimated. Iply
"	Pandharpur tank	1,171	Com. water-sup-
Satura	Mhaswad tank	304	In progress.
"	Nehr tank	639	Completed.
Khandesh	? tank	388	Proposed.
"	Mukt tank	708	Completed.
Poona	Shirsupal tank	338	"
"	Matoba tank	542	"

PLATE 3.



AQUEDUCT, 4 ARCHES OF 20 FEET SPAN EACH.

The estimate for these works was duly submitted to the Government of Bombay, who, in April 1877, approved of the project as prepared and forwarded it to the Government of India, by whom it was formally sanctioned. The

PLATE 3.

Fig: 19.

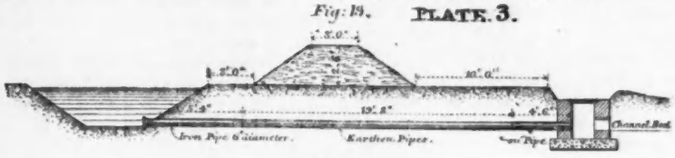
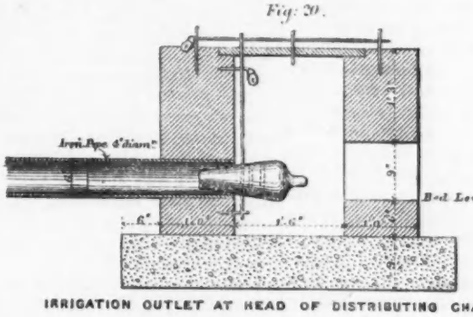
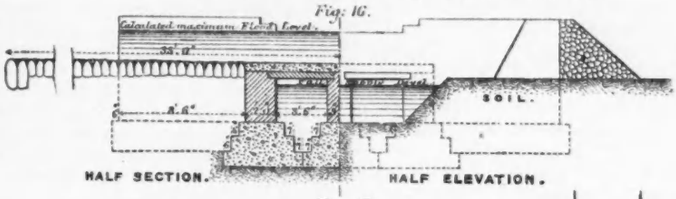


Fig: 20.



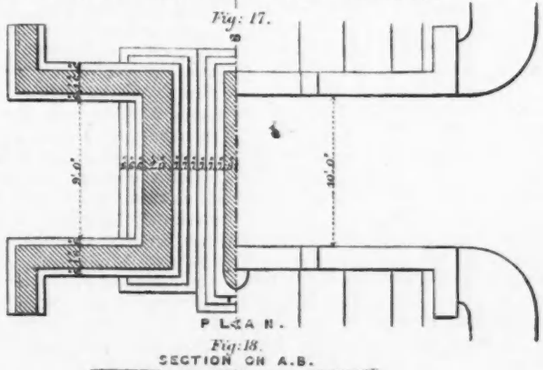
IRRIGATION OUTLET AT HEAD OF DISTRIBUTING CHANNELS.

Fig: 16.



HALF SECTION. HALF ELEVATION.

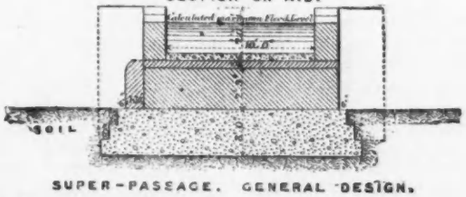
Fig: 17.



PLAN.

Fig: 18.

SECTION ON A.B.



SUPER-PASSAGE. GENERAL DESIGN.

following is an abstract of the estimate so sanctioned.

DIRECT CHARGES.

	Rupees.
Works	555,418
Establishment	111,100
Tools and plant	11,100
Total direct charges	677,618

INDIRECT CHARGES.

Capitalization	12,000
Leave and pension allowances	22,200
Interest	87,120
Total indirect charges	121,320
Grand Total	798,938

In March 1882, when all the works connected with the tank and the greater part of those connected with both canals were completed, a revised estimate was prepared by the Author, which includes the provision of extra works, such as plantations, surveys for the sub-division of land under command of the canals into small numbers suitable for irrigation, branch canals, etc., the estimated cost of which amounted to Rs. 19,367 and which are provided for from savings effected during the construction of the works. Notwithstanding this provision for extra works, there is still, it will be observed, a saving of Rs. 8,117 on the original sanctioned estimate:—

ABSTRACT OF DIRECT CHARGES.

	Rupees.
Works	547,301
Establishment	118,228
Tools and Plant	10,946
Total direct charges	676,475

Thus the total cost of works is Rs. 547,301 as compared with Rs. 558,418 sanctioned in 1877, and the total direct charges are Rs. 676,475 as compared with Rs. 677,618.

The revenue, based upon rates current on other works, was calculated as follows: The supply of water available, after deducting the loss by evaporation is estimated to be sufficient for the irrigation of 8000 acres in quadrennial rotation, thus:—

Acres.		Rupees.	Rupees.
2,000	Sugar, at	10	20,000
2,000	Rabi "	4	8,000
2,000	Rice "	4	8,000
2,000	Monsoon dry-crops, "	1	2,000
8,000			38,000

On the assumption that water is not used for rice irrigation, and that a triennial rotation is adopted, the areas and revenue, on the same data, would be—

Acres.		Rupees.	Rupees.
3,603	Sugar, at	10	36,030
3,603	Rabi "	4	14,412
3,603	dry-crops, "	1	3,603
10,809			54,045

The working expenses are taken at Rs. 12,000 per annum, including the cost of establishment and collection charges, etc., The net revenue, if the water is used on the basis of a quadrennial rotation, will be—

	Rupees.	Rupees.
Gross revenue		38,000
Deduct revenue charges—		
Maintenance	12,000	
Payment to Native State	900	
		12,900
Net revenue		25,100

Or 3.70 per cent. on the estimated outlay, Rs. 677,618, for direct charges, and 3.14 per cent. on the total outlay, Rs. 798,938, including indirect as well as direct charges. If the water is used to the greatest advantage, or according to the estimate calculated on the basis of a triennial rotation, the ultimate net revenue will be Rs. 41,145, or 6.06 per cent. on the estimated amount of direct charges, and 5.15 per cent. on the grand total. A mean between these two calculations gives a net revenue of Rs. 33,125, or 4.89 and 4.15 per cent. on total direct, and grand total direct and indirect charges respectively, which is probably the result more likely to be attained within a reasonable period. There will also be some revenue from land taken up for the works, which will become available for cultivation or grazing as the water subsides each year; also from fishing in the tank, and from plantations. Further, there will probably be some return from the sale of water-power available at the dam, which in this situation ought to be very valuable. With a clear fall of 4 feet, the theoretical power due to the discharges in the canals, at their full supply, is about 18 HP., which might be profitably utilized.

The officers employed in the supervision of the construction and in the general management of the works have been: Mr. C. T. Burke, B. E., Executive Engineer, from the commencement; Mr. A. McD. Salmon, Assistant Engineer, from the 1st, of February, 1877, to the 30th of November, 1877; Mr. W. W. Wellis, Superintendent of the Ashti convict gang; Mr. Daji Succaram, Overseer, since the 1st of December, 1877. The direction establishment has been: Colonel C. J. Merriman, C. S. I., R. E., Chief Engineer, from the commencement to August, 1877; Mr. J. H. E. Hart, M. Inst. C. E., Chief Engineer, since August 1877; Mr. W. C. Hughes, Assistant to the Chief Engineer, from the commencement to April 1880; Mr. W. H. Le Quesne, Assistant to the Chief Engineer, since April 1880.

Mexican News.

Railway building in Mexico continues with considerable energy in several sections. The lines on which work is now being done to any extent are situated mostly in the States of Vera Cruz and Hidalgo, and the lines under construction are all short local ones or connecting links to trunk systems.

Work on the Campeche and Calkini Railroad is being vigorously pushed, a large number of men being employed. It is anticipated that it will be completed by Sept. 16 next.

The preliminary surveys of the line connecting Motul and Izmal with Merida were completed last week, and the work of track laying will soon be commenced. The Tulancingo Railway has twelve kilometres completed, and the company has announced a low rate of freight—$1.52 per ton; that is low for this country!—and it is believed that this will encourage the farmers to send their produce to market by this line, which taps an important agricultural section. Before the end of the present year the important town of Perote will be connected with the capital by railway. The line will, in the course of the year 1885, be extended to Jalapa, and early in 1886 it will be completely finished to Vera Cruz. The country through which it passes is flat, the grades are very easy for most of the distance, and no serious engineering difficulties are presented.

Engineering News

AND

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Make all drafts, cheques and money orders payable to **Engineering News Publishing Co.**

Wanted: a Hand-book for City Engineers.

Judging from frequent queries reaching this office, a Hand-book for City Engineers would be a timely and popular addition to our professional literature.

The applicants for the information such a book should contain, are not the engineers of our larger cities, who are presumedly already experts, but the newly appointed official in the town which for the first time aspires to the dignity of a public water-supply, improved streets, drainage and the many requirements for the convenience and comfort of the citizens brought about by modern institutions. It would apply where the office is comparatively new and the officials practically inexperienced.

To say that none but men already experienced should fill the office, does not meet the actual conditions of the case. Local influence will, nine times out of ten, control the appointment, and the man selected may be an excellent engineer in other branches of his profession; but where neither the appointing powers nor the appointee have any clear conception of the duties of the office all must, for a time at least, blunder together, and bring about a condition of affairs neither creditable nor profitable to the parties concerned. It is for the relief of this class especially that such a work is needed; though a careful study and application of modern practice would be profitable to many of our older towns as well.

English officials have their "Borough Surveyor," the "Suggestions" of Rawlinson and other similar works to guide them; but their practice is not our practice, and the rules applicable in England are of little service in our newer American towns.

As a hint to the wished-for author of the Hand-book, we select a few from among the many queries coming to this office; they outline the nature and scope of the work. Many of these questions are undoubtedly easy of solution to the expert, and may seem unworthy of serious attention; but it is the simple problems that seem to befog and trouble the beginner. And when we say that some of these easy questions come from men who have done excellent work as railroad engineers, have been engaged upon coast survey, and in other ways have shown their general fitness, we more fully realize the necessity for a clear and accessible statement of general American practice.

Some of these queries are as follows:

1. Position of water main under streets and their connection with the houses; depth below crown of street, etc.

2. Best position for gas-pipe, so that they may be accessible with the least amount of work for repairs, distance from curb, etc.

3. Mode of laying drains to carry off storm-water from the down-spouts of houses, giving plans of most approved and prevailing systems.

4. Manner of draining back buildings which cannot discharge their roof water into rear street.

5. Street construction; crowning under different conditions of material used: best forms of cross-section, with plans.

6. Manner of establishing grades for side-walks when street is built up and one side from 1 to 5 ft. higher than the other; how to crown the street in such case. "Reply not to be to cut them down on one side and raise them on the other, because City Councils veto that arrangement, and property owners sue for damages."

7. Street-gutters; best form and dimensions; manner of building them across streets; turning corners, etc.

8. Street-grades; vertical curves; easing grades at crossings by other streets of greater or less declivity; elevations of side-walks at corners, where say, a grade of 1 in 125 crosses another 1 in 30; meeting of four different grades.

9. Settling of disputed street lines, where parties have been in the streets for years.

10. The authority of the City Engineer; his duties; from whom he should receive his orders; what force he should control; has he charge of repairs, etc.?

The 10th query is one frequently put, and in new towns especially, there seems to be a perpetual jar in the personal relations of engineer, councils and property owners. This is a question that has frequently come to the surface before, and has been settled by local enactment. But how?

The vexed question of disputed property lines and the relative rights of corporation and citizens is also worthy of general advice founded upon the established custom of older towns.

It is too much to expect a work that would meet every case that might arise; and local conditions would undoubtedly modify any suggestions made. But with a guide of this kind before him, showing the practice brought about by mature experience, any intelligent engineer could so modify his plans that they would be capable of expansion to meet future requirements.

We believe the discussion of this subject will be valuable to a rapidly increasing class of engineers, and serve the best interests of the communities in their charge. With this end in view we will gladly open our columns to any practical articles upon the subject, and to suggestions, queries and answers; only asking that they be concise, clear in expression, and of general value.

AN experimental car will soon commence to run on a Cleveland electric railroad about a mile and a half in length. The system is to be known by the name of its inventors, Bentley and Knight. The leading features are generators at fixed stations, an insulated cable laid in a conduit, from which the current is taken by copper brushes and passed through an electro-motor in the car. If successful in Cleveland the inventors have designs on New York City

The Sewerage of East Orange, N. J.

The Town Improvement Society of East Orange, N. J., has unanimously adopted a report upon the proposed sewerage of the Township of East Orange, which contains many suggestions and recommendations of general interest and value.

The population of East Orange has increased 96 per cent. in the decade, 1870-1880, and at the present date may be assumed to be about 9,000; the present taxable valuation of of property is $5,000,000. The present daily water consumption, from the public supply, is about 200,000 gallons, and including the supply from wells and cisterns, the total consumption is about 300,000 gallons daily.

The citizens, having wisely determined that the proposed sewerage should be thorough, and the work as done form part of a complete and carefully planned system, secured the services of Mr. J. J. R. Croes, M. Am. Soc. C. E., as their consulting engineer, and it is from the able report of Mr. Croes that the following points are taken; which would apply equally well to other towns as unfavorably situated as the town in question.

The topographical position of East Orange is such that the ultimate disposal of the sewage assumes especial importance. The town is surrounded by streams traversing adjoining towns, and by other political organizations across whose territory the drainage would have to pass to reach tide water. Any plan proposed must therefore provide for the treatment of the sewage so that it may be made harmless and unobjectionable to the adjoining communities.

Any method of treatment being comparatively costly, the prime object of the system to be adopted would be the reduction of the quantity to be purified. For this reason Mr. Croes recommends that the rain water be excluded as much as possible from the sewerage channels, and submits a plan in which the sewers are proportioned to convey, when running half full, the greatest probable discharge of sewage at the hour of maximum flow, in this case ½ a cu. ft. per minute for every 100 ft. of street. The sewers range from 6 in. diameter to the main outlet which is an elliptical brick sewer 2 ft. 4 in. wide by 3 ft. 6 in. high. The gradients being light on the summits, flush tanks are necessary at the head of each primary sewer; the tanks to discharge about 100 gallons in 40 or 60 second once in 24 hours.

As it is most economical to concentrate at one point the reduction of the sewage, the system has been so designed; but the plan admits of a division into three natural drainage districts, should this be deemed more advisable.

The total length of streets which will probably furnish sewage to the outlet is 60 miles. The plan submitted includes 40 miles of sewers, 26 miles of which will be 6 in. in diameter. The sewers from 6 in. to 20 in. in diameter should be carefully selected vitrified stoneware pipe, laid true to line and grade, with joints caulked with oakum and packed with best Portland cement. A drain tile is recommended for all wet ground, which should discharge into the nearest water course, or, where practicable, into a flush tank on a lower level of sewers.

It is desirable that branches for house connection be put in at the time of laying the sewers, in sufficient number to provide for the future demand; that connections of sewers should be made by curves of 50 ft. radius, terminating in Y branches; that manholes be put in at not more than 1,000 ft. intervals, and that smaller openings should be provided on small sewers about 300 ft apart.

In speaking of the ultimate disposal of the sewage, Mr. Croes says; that the irrigation system requires more area than can be afforded for this purpose in East Orange. Sub-surface irrigation by small tile-drains, laid 10 in.

under ground, requires an area of 2 acres to every 1,000 inhabitants, and the preparation of requisite ground, and the attendance, for a town of 10,000 inhabitants, would be very costly.

Chemical purification involves too great a volume of water to be handled with economy.

Mechanical filtration usually fails from the clogging of the surface of the filter by the sludge, but Mr. Croes finally recommends this system of treatment in connection with the Farquhar-Oldham filter, with the addition to the sewage flow, of perchloride of iron, in the proportion of one part to 22,000. The recommendation of the filter named is based upon actual trial and the machine is so constructed that a constantly revolving cutter removes the filth as it is deposited upon the surface of the filtering medium, which is sawdust.

The plan recommended includes a tight masonry receiving tank at the outlet, and a steam pump to lift the sewage 20 ft. above the filter into another tank, where the perchloride of iron is added to deodorize the sewage; the discharge from the filter is clear and harmless.

To purify 100,000 gallons of sewage per day the tank and pumps are estimated to cost $3,000 and a filter, 8 ft. in diameter, $3,000; 5 gallons of perchloride of iron, costing $1.50, and 60 cub. ft. of sawdust would be required daily.

To purify 300,000 gallons per day, the cost would probably be $15,000, for plant; the labor in both cases is estimated at $5 per day. The preparation of land for receiving the filtered sewage and transmitting it to the streams would cost about $250 per acre; three acres of ground would suffice for the present demands of East Orange. Sub-surface irrigation, by laying a net-work of tile-drains 10 in. under ground, would cost $2,000 per acre.

The approximate estimate for the entire sewerage of East Orange, as submitted by Mr. Croes is $329,860, though much of this work would not be needed for some years.

Nut-Locks, Even and Broken Joints and Cross-Ties.

From the responses to queries upon the above subject, issued in circular-form by the *Railroad Gazette*, we condense the following:

Eastern Extension Railway.—Am in favor of even joints, as they, to a great extent prevent oscillating motion at high rates of speed. Even joints laid on a sleeper with 12 in. face make a solid joint, require less sleepers than broken joint, less work for section men, and are of advantage in lifting track.

R. French, Chf. Eng., Cleveland, Mt. Vernon and Delaware.—Broken joints were first used as a bond in the *continuity* or *transmission* of strength in the track; but as railroads developed, the road-bed in many cases became less a "permanent way," rails were bad, ballast poor, the rail-ends became low and battered, and jolting and oscillation followed. To meet this jolt *squarely* the even joint was introduced. But with the improved road-bed of the last eight years, steel rails, improved joints and better ballast, I think the broken joint preferable. The advantages, with good road-bed, are, the better surface and alignment than with a square joint, and better distribution and bonding of weak parts.

Waterman Stone, Supt. Providence, Warren and Bristol.—With first-class ballast, and *well*-cared for track, I believe the broken joint to be the best; a smoother track can be maintained, and it is more convenient in laying track around curves.

With poor ballast and badly kept track, the broken joint will be liable to get out of level, causing oscillation; with such track a square joint is best.

A. H., Norfolk Southern.—I think the Courteney and Trull paper washer superior to any nut-lock in use. Broken joints on curves, even joints on straight line are best on a dirt-bed. On well-ballasted road-bed always prefer broken joints all through. Coarse, clean sand or gravel is better than broken stone for ballast, as the rail will last a third longer and the coarse sand will keep the track as well if not better.

Wm. B Sears, Chf. Eng. Flint and Pere Marquette.—Recommends chemically treated cross-ties as economical. The most effective and cheapest nut-lock seen used is an ordinary *horse-shoe nail*, with hexagonal nuts and slight groove in fish-plate to retain nails. This company use hemlock ties, because they are most abundant and cheapest. Considers white-oak the best tie in its natural state. Thinks cedar would last longer if a suitable cushion of wood or iron was used to prevent cutting.

C. S. Woodward, Chf. Eng., Wisconsin and Michigan R. R.—The practice on his road is to lay even joints; personally he does not like it; has found no advantage in it; when there is much curvature and odd rail lengths, this arrangement has caused much trouble. As regards train action, he thinks the vertical blow in one case fully offset by the oscillation in the other. The Verona nut-lock, being round, turns back with the nut; vulcanized fibre, as also any other elastic substance become hardened and set by constant pressure, and is then no better than metal.

The Vosburg Tunnel.

This tunnel is being built by the Lehigh Valley R. R. Co., on the P. & N. Y. Division, which runs from Wilkesbarre, Pa., to Waverly, N. Y., where it connects with the Erie R. R., making a direct line from New York and Philadelphia to Buffalo.

The tunnel enters the mountain at its narrowest point being but 3,865 feet through, and shortens the distance of the road five and a half miles.

It is being built for double track and standard gauge. In boring through the mountain there was found shale, slate, and sand stone rock which delayed the progress, as the roof required the support of heavy timbers and will have to be arched by stone masonry. The contract was awarded to L. F. Lentz, J. H. Byron, D. C. Hickey and C. E. Brodhead, all experienced men in railroad construction and tunneling. Mr. Brodhead was principal Assistant Engineer to Robt. H. Sayre, Esq., who is now Chief Engineer of the South Pennsylvania R. R., and under his supervision as Engineer of the Easton and Amboy Division of the Long Branch R. R. was built in 1874.

Ground was broken at the approaches of the tunnel in April 1883. The headings opened at East and West Ends in September and August respectively of same year and met July 12, 1884. No shafts were built as the mountain at the approaches was very high and steep.

The greatest progress made in any one month was 497 feet, although when good roof was found 62 and 65 feet per week was driven at each end. The engineering was in charge of A. H. Stedman, Chief Engineer of the R. R. Co. and Mr. G. B. Owen, his efficient assistant, whose personal attention was given to the work, and under such the center lines, grade, and distance did not vary three hundredths of an inch. Mr. Owen is but a young man, and from his engineering skill shown we predict for him a successful career.

The machinery used was the Rand Compressor and Drill at the West End, and the Ingersoll Compressor and Drills at the East End, both giving good satisfaction. The powder used in the headings giving the best satisfaction both in execution of blasting, and the least injurious to the men, was the Rack-a-rock Powder made by the Rand rock Pow-Powder Co. 23 Park Place, N. Y.

PERSONAL.

THE Civil Engineers Club of Minneapolis has been admitted to membership in the Association of Engineering Societies.

MR. C. C. UPHAM, until recently the Chief Engineer of the Tampico Branch of the Mexican Central Railway to the United States, has returned.

AT Gisborne, in New Zealand, in March last, died A. H. BRAITHWAITE, the gentleman who designed the famous locomotive Novelty, which competed in the historical contest on the Liverpool and Manchester Railway with GEORGE STEPHENSON'S Rocket. His age was 83.

A. LANGSTAFF JOHNSON, a well known Civil Engineer of Richmond, Va., and specially connected professionally with several Virginia railroads, has been spending a week in New York. MR. JOHNSON reports railway construction as tolerably quiet in Virginia at present, but full of excellent promise in the very near future.

DAVID O. SAYLOR, President of the "Saylor Portland Cement Co." died at his late residence in Allentown, Pa., on Monday, July 21. Mr. Saylor was well and favorably known as an earlier investigator into the properties of American cement rock; and to his labors in that direction the country is much indebted for the progress made within late years in the manufacture of hydraulic cements.

FREDERICK HERRMANN PŒTSCH, the inventor of the freezing method for sinking shafts and foundations in water-bearing strata, was born in Anhalt, about 1842. He graduated at Freiburg, as a Mining Engineer, and for the first ten years of his active life was engaged as Mining and Smelting Engineer for Anhalt; after that he went into the Prussian State Service as Government Mining Surveyor and Superintendent. He was mainly employed in Saxony, at Ashersleben, and the frequent trouble from quick sand in shaft-sinking in that section early attracted his attention. It was only in February, 1883, however, that the method, patented in October, 1883, suggested itself, and it was at once put in practice in the Archibald Mine, as described in this journal.

MR. PŒTSCH is a patient, persevering and hard working engineer, and for some years past has been devoting himself to the solution of this quick sand problem.

One of the best indication of the European estimation of the merits of his system is the interest taken in it by the very conservative house of Rothschild, of Paris; they have secured the control of the European patents, and stand ready to freely back with capital any application of the Pœtsch methods.

To Measure the Height of a Tree.

There is a very simple way of measuring the height of a tree which can be practiced by any one on a sunny day or in bright moonlight. All the apparatus that is necessary is a straight stick of any length. Draw a circle with a radius (half the diameter) of a little less than the length of the stick. This will be done by holding one end of the stick, say two inches from its end, and moving the other end around, making the circle with a knife or a chip. Then place the stick in the ground exactly in the center of the circle, perfectly upright, and press it down until the height of the stick is exactly the same as the radius of the circle. When the end of the shadow of the stick exactly touches the circle then also the shadow of the tree will be exactly in length the same measurement as its height. Of course, in such a case, the sun will be at an exact angle of 45°. Measurements of this character can be best effected in the Summer, when the sun is powerful, and has reached to a good height in the heavens, and when the trees are clothed with living green so as to cast a dense shadow. To many to whom this idea may not have occurred it might be made annually a matter of interest thus on warm Summer days to take the height of prominent trees, and so to compare growth from year to year.

TURNOUTS:

Exact Formula for their Determination, together with Practical and Accurate Tables for Direct use in the Field.*

BY W. B. PARSONS, JR., C. E., ROADMASTER NEW YORK AND GREENWOOD LAKE DIVISION, ERIE RAILWAY.

(Continued from page 32.)

2nd CASE—TURNOUT FROM CURVE.

1st. When frog is on outside of curve.

Let $B\,C$ and $K\,E$ represent the outer and inner main track rails whose curve centre is A.

Let $B\,E$ represent the inner turnout rail tangent to $K\,E$ at E, the heel of the switch, and intersecting $B\,C$ at B, which is the frog

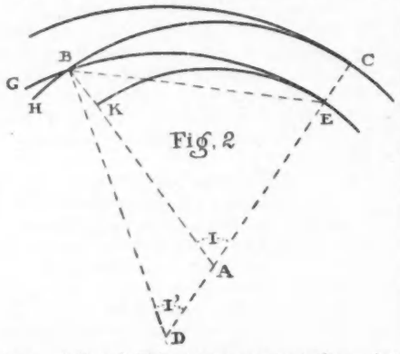

Fig. 2

point. $G\,B$ and $H\,B$ are tangent at the point B to $B\,E$ and $B\,C$ respectively, hence $G\,B\,H$ is the frog angle.

Draw $D\,B$ perpendicular to $G\,B$, hence D is centre of turnout curve. Draw $B\,E$.

Let R denote radius of main track, and R' denote radius of turnout.

Angle $G\,B\,H$ is frog angle denoted by F and $= A\,B\,D$.

Then in triangle $A\,B\,E$;

$A\,B + A\,E : A\,B - A\,E ::$ tan. $\frac{1}{2}(A\,E\,B + A\,B\,E)$: tan $-\frac{1}{2}(A\,E\,B - A\,B\,E)$, but $A\,B = R + \frac{1}{2}\,g$ and $A\,E = R - \frac{1}{2}\,g$.

$\therefore A\,B + A\,E = 2\,R$, and $A\,B - A\,E = g$.

Again, $A\,E\,B = 90^\circ - \frac{1}{2}\,I'$: denoting angle $B\,D\,E$ by I':

and $A\,B\,E = 90^\circ - \frac{1}{2}\,I' - F$,

then $\frac{1}{2}$ sum $= \frac{1}{2}(180^\circ - I' - F)$.

and $\frac{1}{2}$ diff. $= \frac{1}{2}\,F$.

Denoting angle $B\,A\,E$ by I, we have $I = I' + F$.

Substitute, $\frac{1}{2}(180 - I' - F) = 90^\circ - \frac{1}{2}\,I$.

Substitute, in original proportion.

$$2\,R : g :: \text{tan.}\,(90^\circ - \tfrac{1}{2}\,I) : \text{tan.}\,\tfrac{1}{2}\,F.$$

$$\text{tan}\,(90^\circ - \tfrac{1}{2}\,I) = \frac{2\,R\,.\,\text{tan.}\,\frac{1}{2}\,F.}{g}$$

$$\text{or, tan}\,\tfrac{1}{2}\,I = \frac{g}{2\,R\,\text{tan}\,\frac{1}{2}\,F}. \qquad (4)$$

To find length of arc $B\,C$, which gives distance from point of frog to heel of moving rail, which is origin of turnout curve,

$$\text{arc}\,B\,C = \frac{2\,\pi\,(R + \frac{1}{2}\,g)\,I.}{360^\circ} \qquad (5)$$

when measured on outside rail.

Again, $D\,B : A\,B ::$ sin $(180^\circ - I)$: sin I':

reducing, $$D\,B = \frac{(R + \frac{1}{2}\,g)\,\text{sin}\,I}{\text{sin}\,(I - F)}$$

Radius of turnout $R' = D\,B + \frac{1}{2}\,g$

$$\text{whence}\ R' = \frac{(\mathrm{R} + \frac{1}{2}\,g)\,\text{sin}\,I}{\text{sin}\,(I - F)} + \tfrac{1}{2}\,g \qquad (6)$$

To find length of moving rail, let x denote tang. deflec. of chord c^1 of turnout.

Then $x + d$ will denote tang. deflec. of chord c^1_1 of curve, where $d =$ throw.

But $$c^1 = \frac{2\,x\,50}{\text{sin}\,D}, \text{ and } c^2 = \frac{2\,(x + d)\,50}{\text{sin}\,D};$$

equating and solving we get value of x, and substituting this value in either equation we find length of c, which is length of moving rail (7)

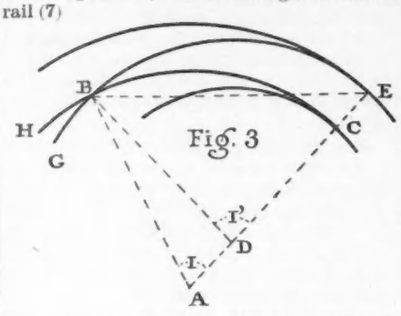

Fig. 3

obtained by formulæ for turnouts from straight line. So the figures given in Table 1 will answer whether turnout is from straight line, or outside or inside of curve. The question of turnout radius (eqs. 6 and 10) evidently varies with curvature of main track. From equation 6, giving value of turnout radius where frog is on outside, it is evident that: R' is minus, that is, turnout curves in opposite direction from main track when $F > I$, in which case R' is greater or less than R as sin. $(I - F)$ is less or greater than sin. I.

Also R' is infinity, that is, turnout is straight or tangent to main track curve when $F = I$, and R' is always greater than R when $F < I$. From equation 10 where frog is on inside R' can never be infinity since $I + F$ can not reduce to 0, and it must always be less than R. since sin. $(I + F)$ is always $>$ sin. I.

Degree of Curvature of Main Track	Location of Frog	FROG NUMBERS							
		6	7	8	9	10	11	12	13
1°	Inside	319.93	426.85	545.09	672.87	808.42	950.02	1096.05	1244.97
	Outside	**360.47**	**502.04**	**673.79**	**880.24**	**1127.33**	**1422.83**	**1777.14**	**2244.32**
2°	Inside	302.88	397.08	497.51	601.88	708.14	814.53	919.62	1022.26
	Outside	**384.81**	**550.45**	**763.84**	**1040.36**	**1403.88**	**1893.38**	**2576.58**	**3583.05**
3°	Inside	287.55	371.18	457.56	544.40	629.94	712.80	792.04	867.07
	Outside	**412.66**	**609.13**	**881.56**	**1271.40**	**1859.62**	**2827.52**	**4680.32**	**9550.83**
4°	Inside	273.68	348.44	423.52	496.93	567.27	633.62	695.50	752.70
	Outside	**444.81**	**681.74**	**1041.96**	**1633.85**	**2752.09**	**5575.45**	**25375.34**	14387.85
5°	Inside	261.09	328.31	394.18	457.05	515.91	570.25	619.90	664.96
	Outside	**482.34**	**773.88**	**1273.44**	**2284.36**	**5286.23**	**190712 16**	7427.76	4106.49
6°	Inside	249.60	310.38	368.64	423.08	473.07	518.37	559.10	595.51
	Outside	**526.74**	**894.64**	**1636.48**	**3792.53**	**65831.91**	5929.03	3241.63	2396.24
7°	Inside	239.07	294.29	346.19	393.81	436.78	475.14	509.14	539.18
	Outside	**580.07**	**1059.82**	**2288.00**	**11133.97**	6306.39	2921.02	2074.16	1692.33
8°	Inside	229.39	279.79	326.32	368.31	405.65	438.55	467.37	492.57
	Outside	**645.31**	**1299.41**	**3797.98**	11931.92	3011.22	1938.76	1525.52	1308.47
9°	Inside	220.47	266.65	308.60	345.91	378.66	407.18	431.93	453.37
	Outside	**726.96**	**1678.26**	**11138.54**	3888.23	1978.76	1451.42	1205.77	1065.84
10°	Inside	212.21	254.68	292.70	326.08	355.04	380.00	401.48	419.95
	Outside	**832.08**	**2367.47**	11978.86	2323.94	1474.09	1160.18	998.46	900.7

2nd. When frog is on inside of curve, the construction being similar to the previous case.

Let R denote radius of main track, R', radius of turnout, and $G\,B\,H =$ frog-angle $(F) = A\,B\,D$.

Then as before;

$A\,E + A\,B : A\,E - A\,B ::$ tan. $\frac{1}{2}(A\,B\,E + A\,E\,B)$: tan. $\frac{1}{2}(A\,B\,E - A\,E\,B)$

$A\,E + A\,B = 2\,R$, $A\,E - A\,B = g$

$A\,B\,E = 90^\circ - \frac{1}{2}\,I' + F$, $A\,E\,B = 90^\circ - \frac{1}{2}\,I'$

subs., $2\,R : g ::$ tan. $(90^\circ - \frac{1}{2}\,I)$: tan $\frac{1}{2}\,F$

$$\text{whence tan}\,\tfrac{1}{2}\,I = \frac{g}{2\,R\,\text{tan}\,\frac{1}{2}\,F} \qquad (8)$$

$$\text{arc}\,B\,C = \frac{2\,\pi(R - \frac{1}{2}\,g)\,I}{360^\circ} \qquad (9)$$

when measured on inside rail.

Again, $D\,B : A\,B ::$ sin I : sin $(180^\circ - I)$;

reducing, $$D\,B = \frac{(\mathrm{R} - \frac{1}{2}\,g)\,\text{sin}\,I}{\text{sin}\,(I + F)}$$

but $R' = D\,B - \frac{1}{2}\,g$.

$$\therefore R' = \frac{(R - \frac{1}{2}\,g)\,\text{sin}\,I}{\text{sin}\,(I + F)} - \tfrac{1}{2}\,g \qquad (10)$$

To find length of moving rail. In this case x will denote tang. deflec. of main track, and $x + d$ the same for turnout;

$$\text{then } c^1 = \frac{2(x + d)\,50}{\text{sin}\,D^1} \text{ and } c^2 = \frac{2\,x\,50}{\text{sin}\,D} \qquad (11)$$

whence solve as before.

An examination of these equations shows: from equation 4 and 8 that the central angle is the same whether turnout is from inside or outside of curve, and from eqs. 5 and 9 that distance from frog point to heel of switch is also the same when measured on same rail. Now the results obtained from formulæ 4 to 11 (excepting 6 and 10) giving relations for turnouts from curves will be found to agree practically for all ordinary cases with those

TO BE CONTINUED.

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CORRESPONDENCE.

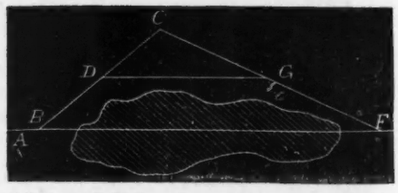
Problem in Surveying.

Special Correspondence Engineering News.

KINGETSTOWN, INDIANA, June 9, 1884.

EDITOR ENGINEERING NEWS.—The proplem in surveying in relation to continuing a line beyond an obstacle without the aid of any measuring instrument, suggests another where the line may be continued by the aid of the chain alone. It is a resultant of the principle that "The line between the middle points of any two sides of any plane triangle is parallel to the third side, and is equal in length to half of it."—[See article on Random Lines, ENGINEERING NEWS, March 4, 1882.]

* The problem is to prolong line A B over an obstruction, as a lake or pond, without the use of an angular instrument.



Solution; Sight from B to a flag or some prominent object in line at F. Measure from B to any point C, and get middle point D. Measure C F, and get middle point G. Measure D G. Twice the length of D G is equal to length of B F.

Yours truly

R. I. MORRISON, C. E.

Irrigation Engineering in the West.

Special Correspondence Engineering News.

DENVER, COL., June 28, 1884

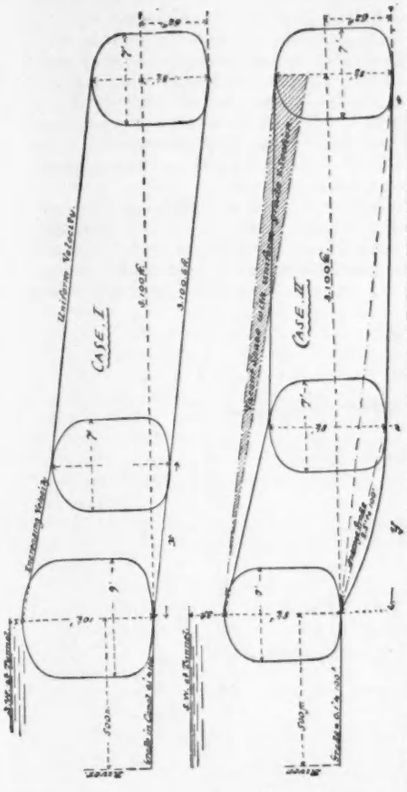
EDITOR ENGINEERING NEWS.—I send you by this mail a sketch showing section of the tunnel and giving the different plans proposed by the Engineer and the Superintendent. I think all data necessary to a full understanding of the question is given on the sheet.

With the data given what would x and y be as marked on the sketch? Would either plan answer? Would both

answer? You will see the vacant space that the superintendent thought would be left in the upper part of tunnel were it drilled straight through on the same grade.

I hope to hear something in regard to the solution of the problems, Respectfully

C. A. MILLER



DENVER, COL., July 3, 1884

I sent you a sketch of the tunnel problem the other day but think there are some other points which it may be well to give. The tunnel is being constructed on a tangent; the head of the water and total fall are given in the sketch. Said sketch is not drawn to any particular scale except in showing the different sizes of the tunnel section

A templet of boards of the size and shape of the smaller of the two sized sections is made to pass through the tunnel; so that the tunnel will be that size in the clear. No particular care will be taken to dress up the edges or sides or any part in fact. The area of the smaller of the tunnel sections is calculated to be 52 sq. feet. It is really less: perhaps 51.35 is about correct.

Respectfully

C. A. MILLER.

The Georgia Capitol.

The Georgia State capitol commission met on the 15th, and adjourned to meet on the 24th of September at 3 o'clock p. m.

There were only two bids for the entire work. Chas. Pierce and Co., Indianapolis, $1,198,202, and Hallowell Granite Co., Maine, $1,163,624. There were besides these 43 partial bids.

After concluding their examination of the bids, Gen. Alexander offered the following resolution:

Resolved, That the board reject all the bids received for furnishing material and the construction of the State capitol.

Resolved secondly, That the commission readvertise for further bids for furnishing material and construction for the State capitol to be received until 4 o'clock p. m., September 24, 1884.

The commissioners then went to work and agreed on the new form of advertisement.

The plans, etc., can be had on application to the commission or at the office of Edbrooke and Burnham, the architects at Chicago. No bids will be considered unless they are made out on the schedule blanks furnished by the commission. In making bids in the competition just closed, a number of bids were thrown out because they were not on the schedule blanks, the bidders not appearing to fully understand the requirements of the commission. Bond and security from the bidders will be required in all cases.

The commission passed an order for the advertisement to be inserted once a week for the two months in the Atlanta *Constitution*, Macon *Telegraph and Messenger*, Columbus *Enquirer-Sun*, Savannah *Morning News*, Augusta *Chronicle and Constitutionalist*, also in ENGINEERING NEWS and AMERICAN CONTRACT JOURNAL, the *Baltimore Sun*, the *Inland Architect*, of Chicago, the St. Louis *Republican*, Cincinnati *Enquirer*, and Louisville *Courier Journal*.

After auditing some accounts, the commission adjourned to meet on the 24th of September.

LITERATURE.

A Treatise on Practical and Theoretical Mine Ventilation. By EUGENE B. WILSON, Instructor in Drifton Industrial School for Miners and Mechanics. New York, JOHN WILEY & SONS, Publishers.

The author has treated his subject in a practical manner, plain and easily understood by the class for whom it was especially intended. But while written for miners, who are not generally recognized as adepts in algebraic formulæ, it will be found useful to the engineer as well.

Commencing with the atmosphere and its constituent parts, the writer describes the various gases, injurious to life, met with in mining, tells what they are and how they may be detected.

The main subject of ventilation is next treated under its many varieties of application and appliances. This section includes a history of mechanical ventilators, and the different safety-lamps in use. In considering the various problems likely to arise, an actual case is given and worked out in plain and simple language to illustrate the special problem.

The work is practical, and reads as if from the pen of one who knows thoroughly of what he writes, from intelligent, personal experience. The absence of intricate formulæ and the substitution of plain English for the obscure mathematical language usually found in works upon this subject, gives the present treatise an especial value, one that will be appreciated by the working miner or engineer.

Recent Progress in Dynamo-Electric Machines, being a supplement to Dynamo-Machinery. By PROF. SYLVANUS P. THOMPSON, B. A., D. Sc., M. S. T. E. Van Nostrand Science Series No. 75. Price 50 cts.

The title of the above sufficiently explains itself; it is a gathering together of the most recent discoveries and inventions in this important class of machinery.

The present work, being really a supplementary paper to a series of three Cantor lectures delivered somewhat more than a year ago by Prof. Thompson, is simple a review of late progress in this subject.

Modern Reproductive Graphic Processes. By JAS. S. PETTIT, First Lieut. U. S. Infantry. Van Nostrand Science Series, No. 76. Price 50 cts.

This paper was originally prepared as a basis for elementary instruction, in the U. S. Military Academy, in the means adopted in the reproduction of prints and drawings.

This feature of rapid, and in many cases very cheap reproductions has become a potent factor in modern journalism of almost every class. The processes vary as widely in the methods adopted as they do in the grade of work produced and in the cost of the product.

Lieut. Pettit has brought together and explained briefly but plainly the various processes of reproduction of prints and drawings, as employed to-day, and classified them under seven main heads as follows: Sensitive paper processes; Hectograph, Engraving, Electrotype, Lithography, Photography and Miscellaneous. Each of these processes is described along with their varieties and the result is an interesting and useful treatise upon the subject.

The Proper Mode of Subdividing a Full Government Quarter Section.*

BY Z. A. ENOS, MEMBER OF THE WESTERN SOCIETY OF ENGINEERS.

I am not aware that the legal mode of subdividing a Government quarter section of land has been determined by the courts, and the opinions of those persons whose official positions, reputations, or occupations should give weight to their views, differ widely as to the construction to be given to the laws of Congress on the subject. I find James M. Edmund, Commissioner of the General Land Office, Hawes' Manual of U. S. Surveying, and J. Dunn's U. S. Land Laws, holding that a full quarter-section, to be legally divided into half quarter-sections, must have a straight line run through it north and south, connecting the quarter mile or quarter corners on the north and south boundary lines of the section; and then, to properly subdivide it into quarter quarter-sections, another straight line must be run through it east and west, connecting the corresponding opposite quarter quarter-section corners on the east and west boundary lines of the section. The point of inter-section of the north and south mile line with the interior or common boundary line of two quarters of the section being the half quarter-section corner, and the point of intersection of the east and west mile line with the other interior or common boundary line of two quarters of the section being the quarter quarter-section corner, and the point of intersection of the two mile lines being the center of the quarter-section. On the other hand the instructions of the Surveyor-General for Illinois and Missouri; Henry A. Wilts, Surveyor-General for Iowa and Wisconsin, and Judge Wm. A. Burts Key to the Solar Compass, direct that an equal division of each of the four boundary lines of the quarter-section shall be made. And a straight line connecting the division points in the north and south boundaries of the quarter-section divides it into half quarter-sections; and another straight line connecting the division points in the east and west boundary lines of the quarter-section divides the quarter-section into quarter quarter-sections, the center of the quarter-section being the point of intersection of the two straight lines.

The accompanying plat of a full Government section and its sub division into quarter-sections, half quarter-sections and quarter quarter-sections, will illustrate how the two modes of subdividing a quarter-section may produce very different results. If the out boundaries of the section have been accurately surveyed, there will be no difference; but if the survey has been imperfectly made, and the section lines crooked (as represented by the plat—and inaccuracy, in fact, is the rule and not the exception), then a difference in the division will follow. In this instance the full lines show the section and its subdivision into quarter sections, the dotted lines show the first mode of dividing the quarter-section, and the dashed or broken lines the second mode, and the combination of dots and dashes shows the agreement of the two methods.

Neither of the parties above referred to has cited an authority or given a reason for his interpretation of the law, nor against the construction of those holding an opposite view. For the choice I have made between these two conflicting views, I propose now to submit for

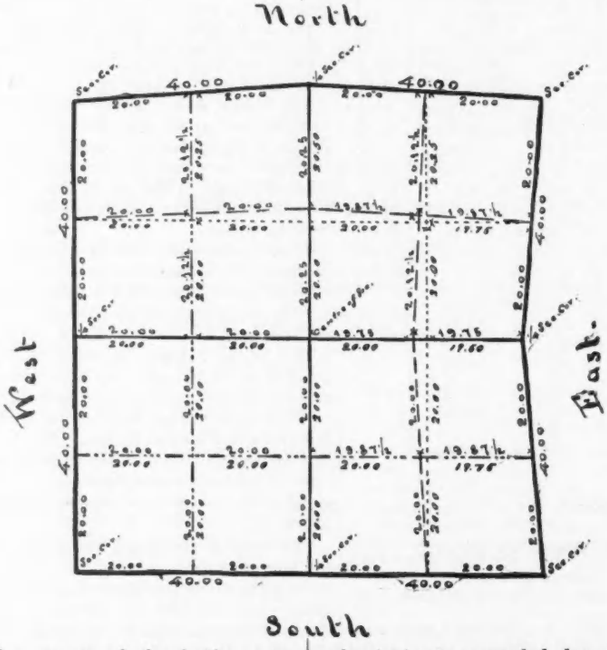
* Read May 20, 1884, and reprinted from the Journal of the Associated Engineering Societies for July, 1884.

your consideration some of the reasons that occur to me in favor of the one construction and against the other. By the act of Congress of February 11, 1805, concerning the mode of surveying the public lands of the United States (in order to legally divide a section into quarter-sections, establish their boundaries and the center of the section or common corner of the four quarter-sections), I believe it is now universally admitted that straight lines must be run through the section east and west and north and south, connecting the opposite corresponding government quarter-section corners. The point of intersection of these straight lines is the center of the section and common corner of the four quarter-sections; and the halves of these lines (so made by intersection) forming two sides of each of the four quarter-sections, the remaining eight sides having been made by the United States Deputy Surveyor's dividing each of the four sides of the section into equal halves.

Thus quarter-sections are formed one-half a mile square, with three corners and two half-mile lines, each established by the government survey, and one corner and two half-mile boundary lines by private survey. Nor would a fourth of a section surveyed in any other manner than the square shape, as above indicated, be sold and patented as a quarter-section. For instance, should the four corners of the section be connected by diagonal lines, dividing the section into four equal triangles, these triangles would not be considered quarter sections as contemplated in law. Nor if straight lines were run north and south from points half-way between the quarter corners and section corners, thus dividing the section into four equal parts, each a mile long and a fourth of a mile wide, it would not be a compliance with the act of Congress for establishing quarter-sections; and they could not be sold and patented as quarter-sections. They would be a violation of the law both in mode of division and in form; and being unauthorized subdivisions and contrary to the manner prescribed by the act of Congress for the division of sections into quarter-sections, would therefore be illegal. And any subdivision of such illegal quarter-sections, either into quarter-sections or quarter quarter-sections (whether as east and west halves or north and south halves or quarters) would of course be illegal; the parts must necessarily partake of the character of the whole; for there can be no more self-evident truism than that if the whole is illegal, its several parts or divisions are illegal, and if the parts are legal the whole must be legal.

Then upon what principle can it be claimed that by simply changing the name of one of these illegal subdivisions of an illegal quarter-section it is thereby legalized? Thus, should we take one of those shoestring fourths of a section, a mile long by one-fourth of a mile wide; for example say the east fourth of the section, and divide it into north and south halves by an east and west line through the qaarter corners of the section. Then take one of these illegal halves, say the north half of the east fourth, and call it by the name of the east half of the northeast quarter, and it thereupon immediately becomes a legal subdivision, and that, too, without any regard to whether it corresponds with an actual half of the northeast quarter, either in shape, length of lines or area, ignoring as it appears to me the plain wording and obvious intent of the acts of Congress of 1820 and 1832 in relation to the sale of the public lands, which requires that the corners for half quarter-sections and quarter quarter-sections shall be ascertained in the manner and on the principles directed and prescribed by the 2d Section of the act of Congress of February 11, 1805.

Now, in what manner did the Act of 1805 direct that the half or quarter-section corners should be ascertained? Clearly by bisecting the section lines, by running each section line with compass and chain and establishing the half or quarter-section corners on true line between, and equal distance from, the corners of the section; or, in the words of the act, "the corners of half and quarter-sections shall be placed as nearly as possible equidistant from those two corners which stand on the same line." And then in regard to establishing the center of the section, the language of the act is, "and the boundary lines which shall not have been actually run and marked as aforesaid, shall be ascertained by running straight lines from the established corners to the opposite corresponding corners." That is, to establish the center of the section, the common quarter corner for the four quarters of the section, it must be made by the intersection of straight lines from these established corners at the equidistant points, as previously stated, and as by the acts of 1820 and 1832 it is provided that the corners of the half quarter-sections and quarter quarter-sections shall be ascertained in the manner and on the principle by which the half and quarter-section corners of the section are ascertained, is it not evident that the lines of the quarter-section will have to be surveyed and quarter quarter-section corners established at equal distances between the corners of the quarter-section on each of its four sides, and then straight lines run connecting these opposite quarter quarter corners, thus forming half quarter-sertions and quarter quarter-sections.



The acts of Congress of 1820 and 1832 did not provide for the subdivision of sections into half sections and quarter-sections; they had already been authorized by the Act of 1805 and other acts. Neither did they provide for the dividing the section into eighths or sixteenths of a section, nor for the subdivision of the section in any manner whatever; but what they did provide was that the quarter-section, as authorized by the Act of 1805 and other acts, should be divided into halves and quarters, and these subdivisions are by law accordingly so designated as the half of the quarter-section and the quarter of the quarter-section. And a Government quarter-section, as we have shown, is a legal subdivision of land having certain fixed or determinable boundaries and corners, that may be easily and accurately ascertained, and the four sides of which are each susceptible of being divided into equal halves, and corners made at the division points, with a center fixed at the intersection of straight lines connecting their opposite corresponding quarter quarter corners in the same manner and on the principle as directed and prescribed by the Act of 1805 for establishing the quarter-section corners and the center of the section. And it is not a compliance with the law to divide two of the lines of a quarter-section equally and two unequally, or to fix its center by running straight lines from corners at its equal divisions to corresponding opposite corners in other quarter-sections a mile distant. As well might it be claimed that a center of the section should or could be made by the intersection of straight lines drawn from the quarter corners on the township line to their opposite corresponding quarter corners on the township line.

As the law does not provide for the subdivision of a section into eighths or sixteenths, but does provide for the subdivision and sale of the quarter-section into half quarter-sections and quarter quarter-sections, and the entries and patents are so worded, does it not follow that the corners at the equal divisions of the quarter-section lines, and the center at the intersections of straight lines connecting their opposite quarter quarter corners, is the manner directed and prescribed by the acts of 1820 and 1832. You now have the course of reasoning by which I have arrived at my construction of the law. If any one is aware of an adjudicated case in point, or can give other and better reasons for either construction, I should be glad to hear from him; for light and truth are what I seek, and not controversy.

GIGANTIC INTERNATIONAL ENGINEERING PROJECTS.—Says the *Pall Mall Gazette* of July 5th: "Two gigantic engineering schemes force themselves upon public intention this morning. One is the proposal to pierce a railway tunnel through the Pyrenees, the convention for which has just been signed by the French and Spanish International Railway Commission. The other scheme is for the formation of a company to construct an international railway connecting Europe with Persia, India, Burmah and China. It appears that Sir R. M. Stephenson, who has been endeavoring to arrange with the Sublime Porte for the commencement of the works in Turkey for the last thirty-four years, considers that the negotiations are so far advanced as to warrant the formation of a company to work the concession, which he believes he will eventually obtain. He proposes to raise, for making the Asia Minor and Persia sections, a capital of $80,000,000, in 600,000 shares of $400 each, 'of which it is proposed $20,000,000 shall be saved by troops' labor, leaving $60,000,000 to be subscribed.' Sir R. M. Stephenson's hopes to induce the countries through which the line passes to supply troops to make it, we fear, are doomed to inevitable disappointment."

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(*Continued from page* 329, Vol. XI.)

DCLIX. CROOKSTON, MINN.,

Crookston, Minnesota, in lat. 47° 45′ N., long. 96° 85′ W., is the county seat of Polk County, and is built on rolling timber land on Red Lake River, the surrounding country being generally level prairie.

Settled in 1872, it was incorporated a city in 1879.

Water-works were built in 1882 by the city, under the direction of W. D. Hurlbut, the supply being taken from Red Lake River a tortuous stream rising in Red Lake about 75 miles east of the city, and having a water-shed of 52.75 square miles.

A dam is built across the river, constructed of piles driven into blue clay and filled with brush, boulders, gravel and earth, the piles being capped and planked over. The water is pumped directly into the mains by water power, the pump designed by James Walters, and constructed by the Pray Manufacturing Company. The ordinary pressure is 35 lbs. which can be increased for fire purposes to 90 lbs.

Distribution is by ½ mile of cast-iron pipe of 10 to 6 in. diameter, with 4 hydrants, 2 gates, and 5 taps.

The population in 1880 was 1,227; it is now said to be 3,800. The works are principally for fire protection. The cost of works has been $33,800.

The bonded debt is $3,300 at 7 per cent. The expenses in 1883 were $1,238 and the receipts $350.

A board of Water Commissioners control the the works, W. D. Hurlbut is Superintendent.

DCLX. CANANDAIGUA, N. Y.

Canandaigua, New York, in lat. 42° 52′ N., long. 77° 20′ W., the county seat of Ontario, Co., is on Canandaigua Lake.

Settled in January, 1789, it was incorporated a village April 18, 1815.

Water-works were built in 1884 by a private company, after plans of Hinds, Moffett & Co., the supply being taken from the lake at a point 2,600 ft. from the shore.

The water is pumped by a Worthington steam pump of 14 and 20 in. cylinders and 15 in. stroke, having a capacity of 1,500,000 gallons daily lifting 135 ft. to a cylindrical tank 40 ft. in diameter and 40 ft. high, holding 380,000 gallons, and having an elevation above the village of 135 ft.

Distribution is by 7½ miles of cast-iron pipe of 14 to 4 in. diameter with 60 fire hydrants. Service pipes are of iron. The village pays $60 yearly for each hydrant. The population in 1880 was 5,726.

The capital stock of the company is $200,000. The bonded debt is $100,000 at 6 per cent.

F. B. Merrill, is President of the company and Frank W. Allen, Secretary.

DCLXI. DURANGO, COLO.

Durango, La Plata Co., Colorado, in lat. 37° 25′ N., long. 107° 45′ W., is in very rough country on the Rio Animos.

Settled in 1880, it was incorporated a town the same year.

Water-works were built in 1884 by the town, after plans of C. M. Pe-in, taking the supply from the river. A dam 6 ft. high is constructed of logs, rock and earth across the river, and furnishes water both for supply and power. The water is pumped by a pump of 9 in. cylinder and 24 in. stroke made by the Colorado Machine Company, and driven by 2 large water wheels made by Leffel & Co., lifting 350 ft. to a reservoir built in excavation and embankment 100 ft. square and 12 ft. deep with inside slopes 1 to 1 and outside slopes 2 to 1 the bottom and inside slopes being puddled with clay.

Distribution is by 2½ miles of cast-iron pipe of 10 to 6 in. diameter, with 52 fire hydrants, 13 gates, and 70 taps. The population is now said to be 2,500.

The works have cost $72,500. The bonded debt is $80,000 at 8 per cent. G. W. Brown is Mayor of the town.

WATER.

TO WATER-WORKS OFFICIALS.

Croes' Statistical Tables of American Water-Works is the most complete Compendium of Information concerning American Water-works in print. It was published one year ago, and is for the benefit of parties engaged in the Construction, Official Management, or Mechanical Operation of Water-works. If there is any such person, Civil Engineer, Contractor, President, Secretary, Superintendent, or Mechanical Engineer of any Water-works in America, who has use for the book, and who has not got a copy already, we will be pleased to send it to him on receipt of one *five cent postage stamp*, with which to prepay it to his address.

ABERDEEN Dak., has an artesian well 950 feet deep.

THE Water-works of Duluth, Minn., are pumping an average of 313,515 gallons of water per day.

THE towns of Marshall and Mexico, Mo., are agitating the water-works question.

LEXINGTON, Mo., is getting on nicely with its system of works.

FINDLAY, O., is preparing to build water-works. Henry Rawie, C. E. knows all about it.

LINCOLN, NEB., will issue bonds to the amount of $90,000; the proceeds to be devoted to the construction of a system of water-works.

CHEMICAL analysis in the case of water from an artesian well in the lower part of New York City has shown it to be contaminated with sewage and unfit for drinking.

THE Watertown, Mass., Supply Company propose to furnish that town with water, laying thirteen miles of pipe, if the town will pay $6,000, a year for hydrant service.

IT may interest meteorologists to know that the shower recently at Chestnut Hill reservoir gave the heaviest rate of rainfall of any rain for more than five years. According to Mr. Desmond Fitz Gerald's self-recording gauge, at that point 72-100 of an inch fell in seven minutes. The whole shower yielded 7.19-100 inches.—Boston *Transcript*, 19th.

AMONG the bids received by Watertown, Mass., for putting a system of water-works was one from R. D. Wood & Co., of Philadelphia, proposing to lay seventeen miles of cast-iron main pipes, place 175 fire hydrants, construct a reservoir of 2,000,000 gallons capacity, erect a brick pumping station, and put in a Worthington low pressure pump of 1,000,000 gallons capacity at a total expense of $150,000.

THE following firms bid for the contract for furnishing water pipe to the city of Minneapolis; Pray Manufturing Company, $9.95 per foot; North Star Iron Works $9.97 per foot; Adams & Schober, $9.72 per foot. Bids for constructing the lining of the East Side Tunnel were as follows: C. L. Barry, and Culbert at $6.15 per lineal foot; from James Patterson at $4.95 per lineal foot; from Tobin & Fallon at $3.94 per foot: from C. W. Linehan and C. K. Leonard at $7.44 per foot, from John Burns at $5.45 per foot.

THE new engines and pumps for the West Side pumping station, Chicago, were put in operation this week. The pumps are two in number, with cylinders fifty-two inches in diameter, and cost the city $257,000. Their capacity is 30,000,000 gallons of water per day, which, added to the capacity of the old pumps will give the city a water-supply of about 140,000,000, or a surplus over the present average demand of at least 50,000,000 gallons. The increase has been made at a total cost of about $300,000.

EAU CLAIRE, Wis., is considering the following offers to furnish it with water. Cadogan & Morgan of Chicago offer fifteen miles of main and 150 hydrants for $157,000, the system to be worked by steam, supply of water to be taken from Otter Creek. The Holly Manufacturing Company propose a system at the Dells for $173,000. Hinds, Moffett & Co., Watertown N. Y., and Phelps & Harris of Minneapolis submit various plans. All are subject to purchase or management by the city at periods of five, ten, fifteen, or twenty years.

TAKING WATER FROM THE THAMES.—Mr. Philip Bevan's letter in the *Times* on the condition of the Thames comes very opportunely just now. Everybody knew that the water companies took a good deal out of the river, but most people were considerably surprised to learn that the total intake exceeds 70,000,000 gallons daily, and that this quantity will every year increase unless some stop be put to this diversion of the people's water. Scientists, I believe, insist that this intake cannot affect the volume of the stream. Those, however who are not scientists are aware that for every gallon taken out of a river there is a gallon less in the river. Deprive a river of one-seventh of its water and only six-sevenths remain. Deprive it of the remaining six-sevenths, and the result is a waterless depression. After this, it is not difficult to account for the appearance of dry land in the middle of the river at Twickenham and Richmond.

THE Assessor and Collector of Water Rates of St Louis has completed a comparative table giving the condition of the water-works of seven of the largest cities of the Union, the consumption in each city and other interesting data, as follows:

Name of City.	Population 1880	Total Water Revenue	Annual Receipts from Metered Water.
New York.....	1,206,299	$1,970,262.77	$570,000.00
Philadelphia..	847,170	1,627,000.00	.....
Brooklyn	566,563	1,188,232.45	178,170.00
Chicago.	503,185	1,049,576.90	309,294.63
Boston-	362,839	1,401,201.61	378,245.22
St. Louis.....	350,518	736,694.26	247,189.81
Baltimore	313,190	644,629.02	69,786.98
Cincinnati	255,139	534,281.09	93,739.43

The daily average consumption is: New York, 95,000,000 gallons: Philadelphia, 67,647,000 gallons; Brooklyn, 34,620,000 gallons; Chicago, 66,166,000 gallons; Boston, 38,545,000 gallons; St, Louis, 26,023,500 gallons; Baltimore, 27,900,000 gallons, and Cincinnati, 19,401,000, gallons. Meter rate per 1,000 gallons: New York, 13½ cents; Philadelphia, .08 cents; Brooklyn 10 to 15 cents; Chicago, 10 cents; Boston, 20 cents; St. Louis, 12½ to 30 cents; Baltimore, .08 cents, and Cincinnati, .09 cents.

Number of taps or connections: New York, 92,000; Philadelphia, 137,000; Brooklyn, 66,500; Chicago, 78,840; Boston, 62,152; St. Louis, 35,483: Baltimore, 53,000, and Cincinnati, 25,870.

Fire hydrants: New York, 7,152; Philadelphia, 6,119; Brooklyn, 2,970; Chicago, 3,825; Boston 5 ,123; St. Louis, 2173; Baltimore, 916, and Cincinnati, 909.

Meters: New York, 9,912; Philadelphia, 63; Brooklyn, 1,518; Chicago, 2,503; Boston, 2,646: St. Louis, 1,-5,224 Baltimore, 707, and Cincinnati, 972.

THE basis upon which Watertown, Mass., is to go into the water-works question is as follows:—The Watertown Water Supply Company will erect suitable buildings and build suitable filtering galleries, place therein a steam pump of the capacity of 1,000,000 gallons per day, with an auxiliary pump of the capacity of 500,000 gallons per day, build a reservoir equal to that at Haverhill, Mass., at an elevation which shall give a full supply of water to all the houses on White's Hill. The system to be the metallic reservoir and direct pumping plan. The water will be taken daily from the filtering gallery and pumped through the entire piping the surplus finding its way into the reservoir. In this plan you have water at a low temperature fresh daily, and free from impurities, as in the impounding system. And will lay fourteen miles of pipes of wrought-iron cement lined, and of cast-iron, in such proportions as the water company may deem for the mutual interests of their stockholders and of the town, said pipes to be of the following sizes:—Twelve thousand feet of 14 inch, 6000 feet of 12 inch, 4000 feet of 10 inch, 8000 feet of 8 inch, 40,000 feet of 6 inch, 4000 feet of 4 inch, 14 miles and 80 feet, and place on said pipes one hundred and thirty-five three-nozzle hydrants, with necessary gates, stops, blowouts, etc., etc.; and will extend the pipes to such other parts of the town as the town may direct, for the sum of $35 per annum for one hydrant to each tenth of a mile so extended, or when the citizens shall give a satisfactory guarantee to the company of water takers to the amount of $35 per annum for each tenth of a mile of such extension.

The town or any citizen to have the right of placing such additional hydrants on the lines of pipes above named, and the extensions above named, at their own expense, as they may see fit, without additional charge for water therefor, and commence the work as soon as possible and complete as much as possible this season, and complete the entire work and lines of pipe named above within one year from the date of the signing of said contract; and will guarantee the works to be equal to those in the towns of Wakefield, Stoneham, Revere, Dedham, and the city of Haverhill, and will at all times furnish a full and adequate supply of good fresh water for domestic and fire purposes; and will charge to its citizens water rates not to exceed those charged by Wakefield Water Company, and for farmers' use not to exceed those of Arlington. In consideration of the above, the town shall pay to said Watertown Water Supply Company for the use of the one hundred and thirty-five hydrants, as above named, for fire purposes and the practice of the fire department, six thousand dollars per annum and thirty-five dollars per annum for each hydrant on the extended pipe, as above named, all for the term of fifteen years.

NEWS OF THE WEEK.

Miscellaneous.

THE C. I., St. L. & C., will build a bridge over the Big Miami.

THE Board of Aldermen of Salem, Mass., have appropriated $40,000 for dredging North River and putting in tide gates at North Bridge.

MR. GEORGE B. FIELD of St. Louis, is the inventor of a new process for rendering buildings fire-proof. It consists in coating all inflamable parts with cement.

DENVER, Col., is to have a $300,000 post office, for which ground will be broken inside of thirty days. Mr. Peter Barclay of that city is the contractor.

THERE is in Aberdeen, Dakota, an artesian well 950 feet in depth in which the pressure is 150 pounds to the square inch on a five inch head. The flow is about 3,000,000 gallons per day.

A NOVEL suggestion in the matter of getting a reliable foundation when quick sands are encountered, is to drive perforated pipes into them through which green vitrol will be forced. The quick sand will be thus turned into solid rock.

J. S. ANTONEILLE, of Mountain View, Cal., has the contract for 10 miles of the excavation for the Spring Valley Water-works, at Millbroe, California. He also has the contract for the construction of 23 miles of the San Francisco and New Alameda R. R., the work on which is stopped temporarily.

THE bids on the Indianapolis Workhouse were as follows:—John R. Cowie & Co., (John R. Cowie and George Weaver), $87,384; Peter Routier, $92,000; Louis Burton, $94,300; Jungclaus & Schumacher, $91,282; Shover & Christian, $91,676.99; J. W. Hinkley, $94,256. In addition to these, bids were made on different parts of the work as follows: On stone work—Ittenbach & Co.; $18.337.40; Koss & Fritz, $16,-230. On iron work—Fred Noelke, $11,989; Haugh, Ketcham & Co., 12,300; Hemke Iron Fence Company, $17,254.03. On brick work—John Martin, $32,817. On galvanized iron work—Johnson & Bennett, $8,053.24. On painting and glazing—Fred Mack, $1,547. On stone and cement work—Henry Helm, $24,390. The bid of John R. Cowie & Co., which, for the entire work, is the lowest, is itemized as follows:

For the main building	$70,850
For the one-story work-shop	2,694
For the two-story work-shop	7,400
For the chapel	6,390

John R. Cowie & Co's bid for the excavation, brick and stone work was $55,894, the remainder of their bid being for carpenter work, iron work, slating etc.

Railroads and Canals.

NEW ZEALAND has 1462 miles of railroad in operation.

THE contracts for the construction of the Kansas Southern Railroad have been given out.

WORK is progressing slowly on the Winona, Alma and Northern Railroad of Minnesota.

THE Canton, Aberdeen and Nashville branch of the Illinois Central Railroad has reached Aberdeen, Mississippi.

THE Wabash Railroad Company owns some 3,600 miles of road, about 600 locomotives, and 20,000 cars.

ABOUT 25 miles of log railway are under construction in the Michigan lumber region. The average cost is $2000 per mile exclusive of ties.

IT is reported that the Illinois Central is about to construct a new line in Iowa, to run from Manchester to Cedar Rapids,

SHREVEPORT, LA., July 16th. — Ground was broken on the first ten miles of the Bremond Narrow Gauge Railroad to-day.

STEEL rails are quoted at $23.50 in England, and $32. in the United States. There is talk of a still further reduction in the former country.

A CORPS from the Burlington and Missouri road are surveying a line from Hudson, Col., to Cheyenne, a distance of 40 miles.

THE Morgan Railroad Company of Louisiana have built a trestle work over Davis crevasse and will run trains across that until the Mississippi returns within its banks.

THE articles of incorporation of the Hennepin County, Gravity Railway Company, have been filed in Minneapolis. Capital $10,000. Object, the operation of gravity railways in that vicinity.

THE preliminary surveys and estimates of cost for the Columbus, Fort Wayne and Western Railroad have been made and the location will soon be commenced. The New York Construction Company is to build it.

A SCHEME is on foot in Illinois to build a narrow gauge road to be known as the Effingham. Shelbyville and Springfeld branch of the Mount Carmel.

THE California Southern, now reaching from San Diego to San Bernardino, 130 miles, is to be extended to a junction with the Mohave Division of the Southern Pacific.

DURANT, MISS. July 20th.—The first through train over the Canton, Aberdeen and Nashville Railroad, from Aberdeen, arrived here last night.

THE road which Zimmerman and Huntington propose to build from Nashville to Richmond (Ky.) Junction has been officially named Chesapeake and Nashville.

THE grading of the California & Oregon division of the Central Pacific road has been completed to a point forty miles north of Reading, Cal., No more work will be done on the line until work is resumed on the Oregan end.

A SURVEY is making for an extension of the Burlington & Missouri from Hudson, Col., 40 miles to Cheyenne. English and New York capitalists are contemplating the construction of a road north-westward from Cheyenne.

SENATOR VEST'S son, who is attorney for the St, Louis & San Francisco, was in Dallas, Tex., this week, to see about the extension of that road from Fort Smith, Ark., through the Choctaw Nation to Dallas.

THE Livingston extension of the Kentucky Central railroad has been completed, and trains will begin running regularly. This branch includes 40 miles of road running from Richmond to Livingston, Ky.

MESSRS. BAYLOR & BAYLOR, No. 7 North Broad Street, Atlanta, Ga. have just finished a preliminary survey for the Georgia Marble Company, who own about 7,000 acres of land in Pickens County, Georgia. Their quarries are near Tate Station upon the Marietta and North Georgia Railroad, which road is now running from Marietta to Ellijay, in Gilmer county. Three of their largest quarries, "Tate," "Allred" and No, "36" are to be connected with a railroad of the same gauge as that of the Marietta and North Georgia railroad. These quarries can be reached with a good grade and light curvature. The marble is of fine quality containing about ninety-six per cent. of pure carbonate of lime, and it will take a very fine polish. Samples of their marble can be seen at the office of Baylor & Baylor. It will take over seven miles of railroad to connect their three principal quarries, which can be built quickly and at a comparatively light cost. This company expects to build this road at once and it will then ship its marble to all sections of the country. The officers of the company are, H. C. Clements, President; Mr. B. Rawe, Secretary and Treasurer, Mark H. Seddall, Vice-President; J. A. Dowar, General Manager.

NORTHERN AND PACIFIC JUNCTION.—The contract for the junction line of railway between Gravenhurst and Callendar, Ont., was let yesterday. The contractors are Symmes, Dawson, John S. Hendrie and James W. Hendrie, the firm name being Symmes, Dawson, Hendrie & Co. The contractors, sureties are Dr. Ferguson, M. P. for Welland, and Mr. William Hendrie, of Hamilton. The contractors take the whole work, including tracklaying and ballasting, making the line ready in every respect for the rolling stock. Work will be begun at once, and will be pushed with the greatest energy, as the contract calls for its completion by the first of May, 1886. The company is to be congratulated on having placed the work in the hands of men financially strong, of well-known ability, and having great experience.

The importance to Hamilton and Toronto—and indeed to the whole of Western Ontario—of the Northern and Pacific Junction railway cannot be over-estimated. It will give us a second all-rail route to Manitoba, the great Northwest and the Pacific, for the Pacific railway will be finished by the spring of 1885; and it will give us access to the promising regions of northern and northwestern Ontario, a fine country in which lumbering operations are assuming vast proportions, and which will soon furnish homes to thousands of settlers. And it will open up to our trade the best and richest part of Muskoka and Parry Sound districts.

We may add that the line will connect with the Pacific railway at the old Callendar station—not, as the Globe affirmed some time ago, at a point fifteen miles to the east of Lake Nipissing.—*Hamilton, (Ont.,) Spectator*, July 19th.

BETWEEN 500 and 600 men are at work upon the Tampico branch of the Mexican Central. Ninety miles of grading has been completed upon which 25 miles of track has been laid.

THE Narrow Gauge Division of the Pittsburg and Western Road, which extends from Callery Junction to Kane, Pa., a distance of 126 miles, is gradually being changed to standard gauge.

THE contract for the grading of the Illinois Southern and Paducah Road was let to Col. Eaton and P. Daly, of Burlington, Io., and Messrs. Nichols & Shaver, of St. Louis. Work will be commenced at Metropolis, Ill., and pushed through as fast as possible to Carbondale, Ill., so as to complete the road by February 1, 1885.

A COMMITTEE of the Commons has agreed to recommend a loan to the Indian government of $140,000,000 for the purpose of making extensions to their railway system. This grant is based upon the report of the famine commissioners, of 1879, which stated that it would be necessary to build 5,000 miles of railways to prevent a recurrence of famine in India. Another object is to substitute Indian for American wheat in the English markets.

MEXICAN MATTERS.—Work on the San Luis Division of the Mexican Central is interfered with by floods.

Surveys of the San Juan Baptista, Astata & Pamulte Railway are finished, and were submitted yesterday to the minister of public works.

The Government inspector of the Tampico Railway reports travel light because of heavy rains, which also check constructions.

ASHLAND, Wis., is to be the terminus of the Milwaukee, Lake Shore and Western Railroad The contract has been let to Donley & Richards to complete the road from Ashland to the Montreal river by the 1st of July, 1885, and the engineers have begun work locating the road and laying out the docks at Ashland. The latter will be built during the coming winter, and will be ready for shipping ore as soon as road is completed to the Montreal. Work has been completed on the west end as far as Black River, with two thousand men pushing it ahead as rapidly as possible, One thousand men will be put to work at Ashland immediately.

ORDERS having been received to double-track the entire Pennsylvania Schuykill Valley Railroad Line between Norristown and Reading, the contractors within a week will have 200 men at work in the vicinity of Mt. Claire. They are already working on the section above Phœnixville, most of which however, was dug for a double-track in the first place, though but one track was intended to be laid.

Vice-President J. N. DuBarry, has given orders to Chief Engineer Joseph U. Crawford, to double-track the line from Perkiomen to Mt. Claire, opposite Phœnixville. The first train will probably enter Reading early in September, and it is expected that trains will be running regularly between the two points by October 1.

THE certificate of incorporation of the American Cable Railway Company was filed July 17th. The Company is to have a capital stock of $2,000,000, and is to build, own, sell, or let locomotives, cars, and general rolling stock for railways. Its incorporators are George S. Field, James Tillinghast, Chas. E. Danforth, Arthur F. Wilmarth, Edward R. Tinker, Chas. Howard Williams, Frederick K. Clark, Monroe B. Bryant, and Frank Shepard, who with the exception of Messrs. Clark, Bryant, and Shepard, and the addition of Frank B. Stockbridge, are its Trustees for the first year. Messrs. Field, and Tillinghast and of Buffalo; Messrs. Danforth, Wilmarth, and Williams, of New York. Edward R. Tinker, of North Adams, Mass., and F. B. Stockbridge, of Kalamazoo, Mich.

TORONTO, ONT., July 16.—The survey of the Credit Valley extension has been completed and the line located to Windsor. It had been decided to run the line from Ingersoll The road will cross the Great Western line there and run thence in an almost direct line to London, thence passing Hyde Park, and within three-quarters of a mile of Komoka, to a point four miles south of Strathroy. Thence through Louisville to Chatham, passing about four miles north of Glencoe. At Chatham a bridge will be built across the river Thames. About four miles west of that town the line will a second time cross the Great Western track and, passing about one and one-half miles from Jennet's Creek, go nearly direct to Windsor, passing very close to Belle River. The mileage will vary but little from that of the Great Western. Operations will be commenced almost immediately, and the line will be hurried through to completion as fast as possible.